Study of India's Commercial Energy Demand

Final report

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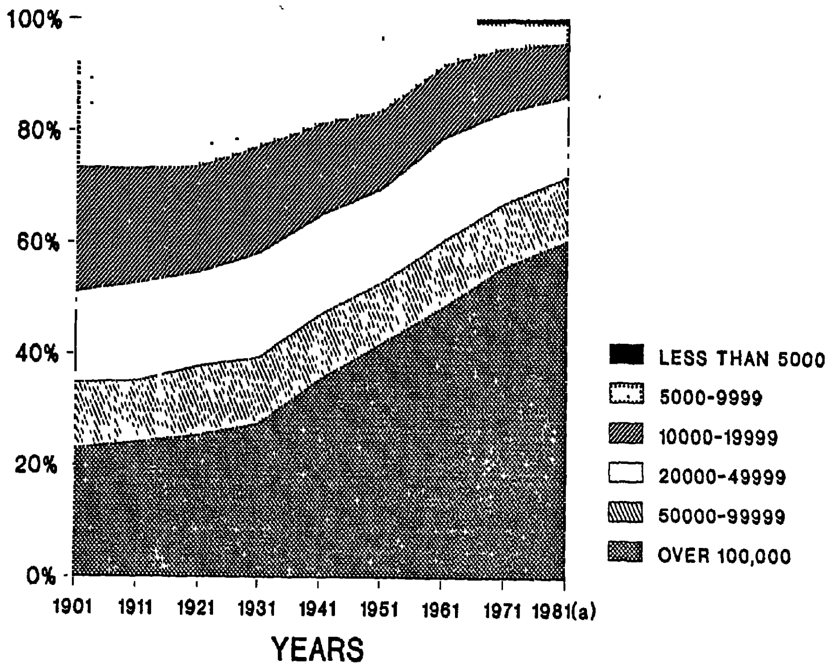
Section 1 : The changing structure of energy demand

1.1 The transition from traditional to commercial forms of energy

India has largely been a biomass based economy, although the situation has been changing rapidly in recent years. The share of biomass fuels in total energy consumption which was in the range of 85 per cent in the year 1953-54 has gone down to approximately 40% as of today. Several factors have been responsible for this shift in the forms of energy that are being consumed over time. To start with, the pressure of an increasing population placed a heavy stress on available biomass resources directly as well as indirectly. The indirect effect was caused due to the need to increase productivity of agriculture to feed a growing population - an increasingly larger share of which was urban based. This lead to the introduction of high yielding varieties of crops with a higher grain to straw ratio. Thus, the availability of crop residue dropped considerably since the late 1960s. In addition, large parts of the country have been experiencing severe deforestation conditions which have resulted in increasing collection times for firewood.

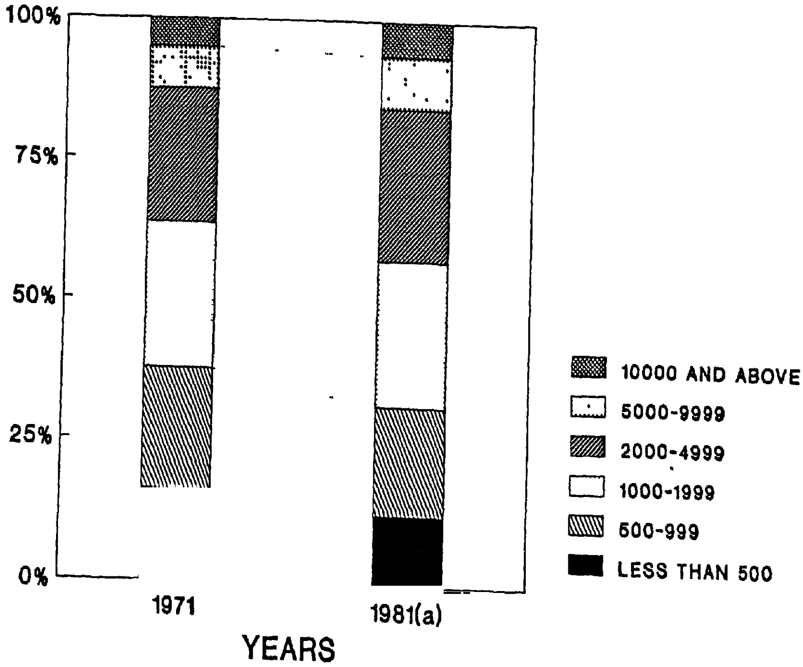
The growing urban population has also resulted in the decline of biomass based energy consumption as it was much easier to access -the more convenient and clean commercial forms of energy. Figure 1.1,1.2 gives an idea of the shifts in population structure over time. Urban and rural populations are either tending to migrate towards larger city/village

FIG. 1.1 URBAN POPULATION DISTRIBUTION



(a) EXCLUDES ASSAM

FIG. 1.2 RURAL POPULATION DISTRIBUTION



(a) EXCLUDES ASSAM

sizes or boundaries are getting redefined, with the burgeoning populations, resulting in the merger of two or more areas. The populations in these larger sized cities/ villages are able to get better organized and therefore lay claims to better infrastructural facilities facilitating the switch over to commercial forms of energy.

Large scale industrialization has been another contributing factor to the growth of commercial energy consumption in total energy consumption. The agricultural sector which contributed to about 60% of gross domestic product (in constant 1970-71 prices) in 1950-51 reduced its share to about 37% in 1985-86. Part of this was made up by increased contribution of the secondary sector consisting largely of manufacturing and construction whose share went up from 14.5% to 21.9% over the same period. However, the tertiary or services sector has grown much more rapidly increasing its contribution from nearly 26% in 1950-51 to over 41% in 1985-86 - a large part of this increase taking place in the late seventies and eighties.

Despite the growing dependence on commercial forms of energy, a comparison of per capita energy consumption levels in India vis-a-vis other countries reveals that consumption levels in India are extremely low at about 200 kgoe per capita per annum against a range of 3000-9000 kgoe per capita in some of the developed countries. The situation would be marginally better if one was to take into account the consumption of biomass forms of energy, which are direct substitutes for commercial forms of energy but the basic disparities would still not change. While this is a good indicator of the low levels of living of the Indian population, what is important are the gross inefficiencies which are built into both our energy production and conversion processes as well as in the utilization technologies. As a result, despite the heavy investments made in enhancing commercial energy supply the economy is faced with serious shortages.

1.2 Shifts in commercial energy demand

Table 1.1 gives recent trends in the availability and consumption of commercial energy. While gross availability of energy, in million tonnes of oil equivalent, has increased at the rate of 6.5% per annum in the period 1980-81 through 1988-89, conversion losses have increased at a much faster rate of 9.1% per annum. As a result net availability has increased at a rate of 5.4% only. Conversion losses have increased due to the following reasons :

i) The share of thermal power in total electricity capacity and generation has increased significantly at the expense of hydel power. A major part of this expansion in thermal electricity production has been based on coal as a fuel rather than natural gas or diesel oil.

ii) With the discovery of larger resources of natural gas in the associated form, the flaring of natural gas which had exhibited a decline up to the early 1980s has increased again to nearly 40-45% of gas production.

iii) Transmission and distribution losses of the electricity sector have been steadily increasing.

iv) The quality of coal has been declining rapidly with the share of lowest grades of coal (E&F) increasing from a little under 18% in 1980-81 to close to 60% in 1989-90. It is anticipated that the share of these grades of coal in total coal production will increase to a level of about 80% by the turn of the century. These grades of coal carry an ash content of as high as 35-40%.

A broad sectoral analysis of energy consumption reveals that the fastest growing sectors in terms of energy consumption are the agricultural and the residential sectors where consumption has grown at 10.1% and 8.2% respectively during this period. In terms of absolute energy consumption, the industrial sector accounts for a major part of energy consumption followed by the transport sector. Utilization of various energy forms for non-energy purposes (naphtha as feedstock, lubes and greases and natural gas used in industry) has also increased rapidly at about 7% per annum, during the same time period.

Table 1.1: Trends in availability and consumption of commercial energy : 1988-89 to 1986-87

(million tonnes of oil equivalent)

	Gross availability	Conversion losses	Net availability/ consumption (col4-9)	Agriculture	Industry	Transport	Residential	Other energy uses	Non energy uses
1972-73	68.483	14.396	54.087 (100.0)	0.78 (1.4)	29.717 (54.9)	13.579 (25.1)	4.533 (8.4)	1.542 (2.9)	3.936 (7.3)
1980-81	92.623	23.859	68.764 (100.0)	1.625 (2.3)	36.861 (53.6)	17.443 (25.4)	5.637 (8.2)	1.901 (2.8)	5.297 (7.7)
1981-82	101.411	26.567	74.844 (100.0)	1.624 (2.2)	40.607 (54.3)	17.787 (23.8)	6.258 (8.3)	2.042 (2.7)	6.526 (8.7)
1982-83	109.023	28.552	80.471 (100.0)	1.861 (2.3)	44.225 (55.0)	18.758 (23.3)	6.82 (8.5)	2.127 (2.6)	6.68 (8.3)
1983-84	114.944	31.261	83.683 (100.0)	1.887 (2.3)	46.265 (55.3)	19.655 (23.5)	7.25 (8.6)	2.214 (2.6)	6.412 (7.7)
1984-85	121.51	34.997	86.513 (100.0)	2.131 (2.5)	46.595 (53.8)	20.309 (23.5)	8.038 (9.3)	2.341 (2.7)	7.099 (8.5)
1985-86	131.425	38.028	93.397 (100.0)	2.389 (2.6)	50.059 (53.6)	21.719 (23.2)	8.773 (9.4)	2.488 (2.7)	7.969 (8.5)
1986-87	141.187	40.927	100.26 (100.0)	2.807 (2.8)	53.423 (53.3)	22.789 (22.7)	9.532 (9.5)	2.677 (2.7)	9.032 (9.0)
1987-88	149.241	47.654	101.587 (100.0)	3.63 (3.6)	51.261 (50.5)	24.476 (24.1)	10.375 (10.2)	2.953 (2.9)	8.892 (8.7)
1988-89	163.606	52.621	110.985 (100.0)	3.861 (3.5)	56.214 (50.6)	26.055 (23.5)	11.532 (10.4)	3.684 (3.3)	9.639 (8.7)

Source : Compiled from energy balances

Figure 1.3,1.4,1.5,1.6 gives changes in demand for parti types of fuels by each sector. Thus, in the cas electricity, over the period 1980-81 to 1988-89, it is that while the share of industry has declined conside that of the agricultural and residential sectors

FIG.1.3 SECTORWISE CONSUMPTION OF ELECTRICITY

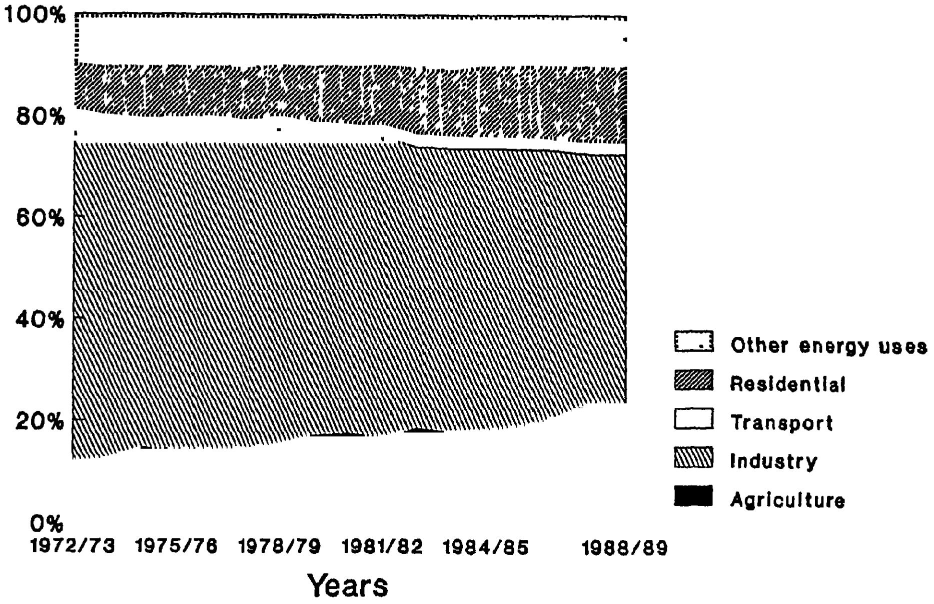
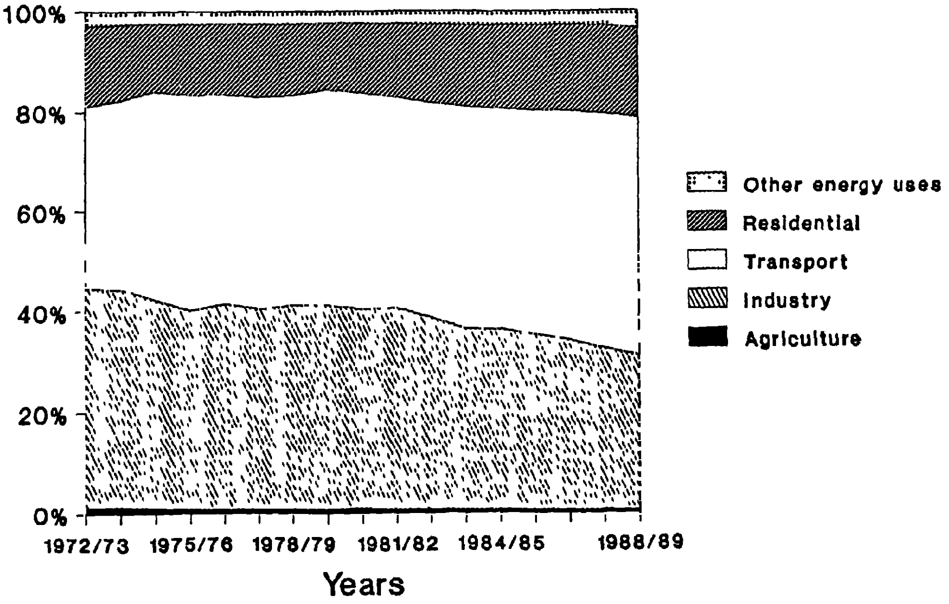


FIG.1.4 SECTORWISE CONSUMPTION OF PETROLEUM PRODUCTS



increased quite significantly. While residential electricity demands have gone up from 11% to 14% of total electricity demands, the issue of significance here is the fact that these demands have been found to coincide with the peak demand placed on various electricity systems either in the early morning hours or evening hours. In the case of the agricultural sector the increase in demand is largely for energy purposes and in a large percentage of cases does not coincide with peak demand periods - this is more because the electricity boards ensure that there is no supply to the rural pumpsets during peak demand periods. While the share of industry has shown a decline, this may not have been the case if electricity supply from the utilities was assured both in terms of quantity and quality.

In the case of oil, the share of the industrial sector has gone down from 39% to about 31% while that of the transportation sector and the domestic sector has increased. The share of the transport sector in oil consumption has increased largely due to the absence of an alternative transportation fuel both in the road sector as well as in the railways. Electrification of rail routes is limited by the density of traffic required to make this an economically efficient option. Similarly, in the domestic sector the only commercial energy alternative to cooking fuels are petroleum based products. Both these factors have contributed to the large middle distillate (SKO, HSD) demand necessitating changes in refinery configurations as well.

A larger percentage of coal consumption is now accounted for by the industrial sector, with a reduction in the shares consumed by all other sectors of the economy - transport, residential and commercial. The decline in coal consumption by the railways sector is due to a conscious policy adopted by the Government of India to phase out the use of highly inefficient steam locomotives in favour of diesel and electric traction. In the case of the household sector, coal consumption has declined not only in percentage terms, but also in absolute terms largely due to the high costs of soft coke production. In this case, the producers are reluctant to go in for soft coke production because of the extremely high levels of subsidies that need to be provided. From the viewpoint of consumers coal compares poorly with oil products such as kerosene and LPG in terms of convenience of use.

Natural gas consumption in the country is still extremely low with well over 40% of natural gas produced being flared even as of today. Of the balance that is utilized, industry accounts for close to 98% of consumption largely for non-energy purposes in the fertilizer and petro-chemicals industries as also for power generation purposes.

FIG.1.5 SECTORWISE CONSUMPTION OF COAL

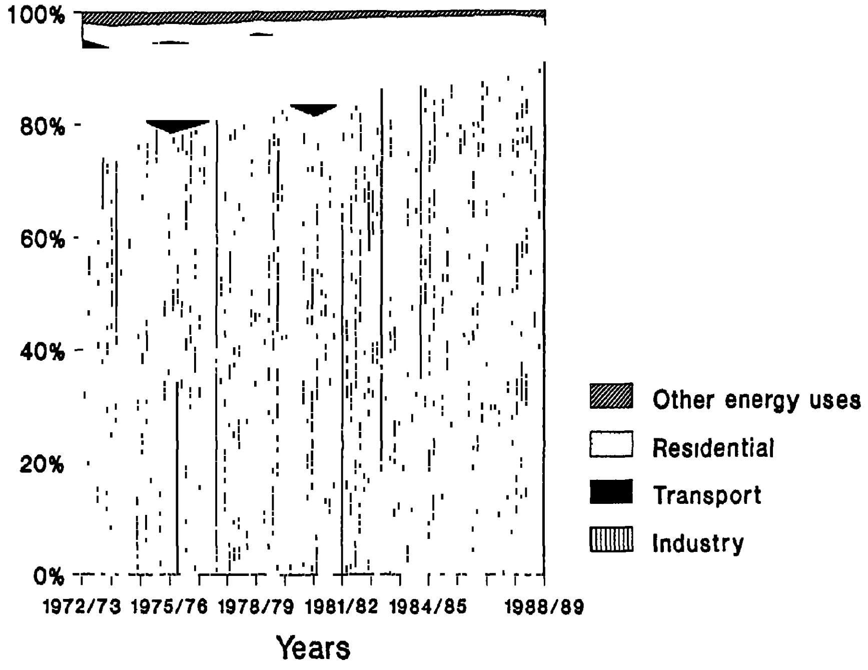
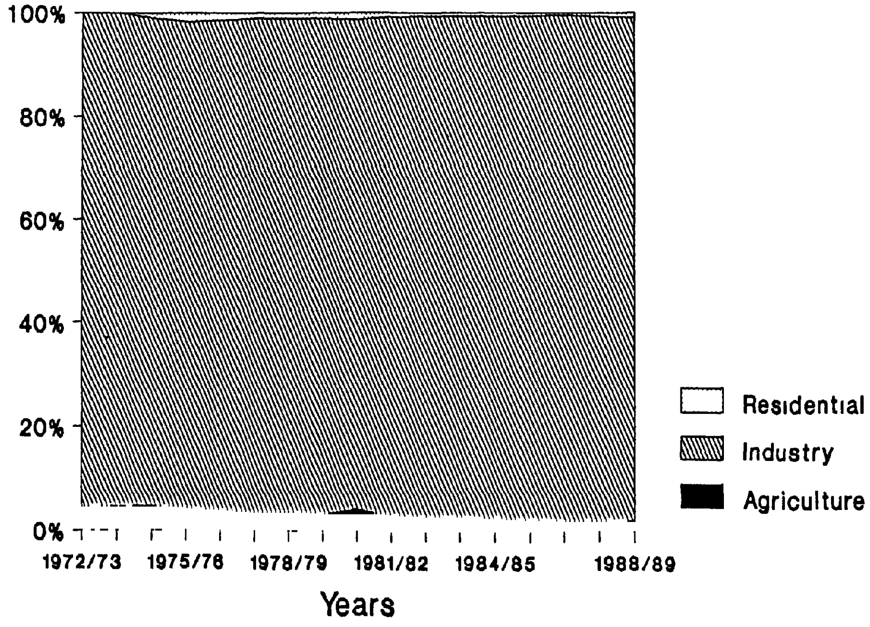


FIG.1.6 SECTORWISE CONSUMPTION OF NATURAL GAS

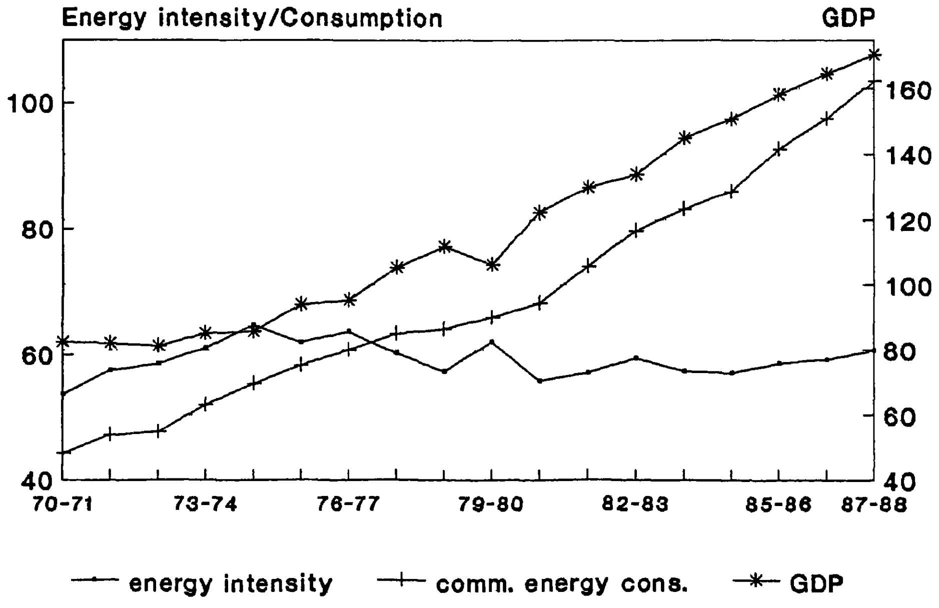


Energy intensity of the Indian economy

Figure 1.7 captures the movements in commercial energy intensity of India's economy. Thus, it is seen that commercial energy intensity of gross domestic product has gone up from a level of 53 kgoe per thousand rupees in 1970-71 to about 59 kgoe per thousand rupees in 1988-89. However, there have been fluctuations in these intensities over different periods of time that reflect fluctuations in energy intensities of largely the industrial and agricultural sectors.

To get a better understanding of the factors that have been determining energy demand, it is essential to carry out an analysis of the changes in energy consumption and intensities of individual sectors.

FIG.1.7 COMMERCIAL ENERGY INTENSITY



- Energy Intensity in toe/Rs million
- Commercial energy consumption in mtoe
- GDP in Rs. '000' crores

1.3 Changes in sectoral energy consumption and intensities

1.3.1 Agriculture Sector

The total energy consumption in the agricultural sector increased rapidly over the period 1971-88. The agricultural sector has been under tremendous pressure to increase productivity not only due to an increasing population in the rural areas, but also due to an increasing non-agricultural based population base.

Agricultural land has been more or less stagnant from the early 1970s. However, there has been an increase in gross cropped area due to the increased intensity of land use through double cropping and multiple-cropping. A large part of this increase in gross cropped area has been possible due to the introduction of high yielding variety of seeds, since the late 1960's, which have reduced the harvesting time of principal cereal crops of the country thereby allowing the growth of more than a single crop on the same piece of land albeit through a more intensive use of inputs such as irrigation, fertilizers etc. Table 1.2 gives an indication of the increase in areas under high yielding variety of crops.

Table 1.2 : Area under high yielding variety

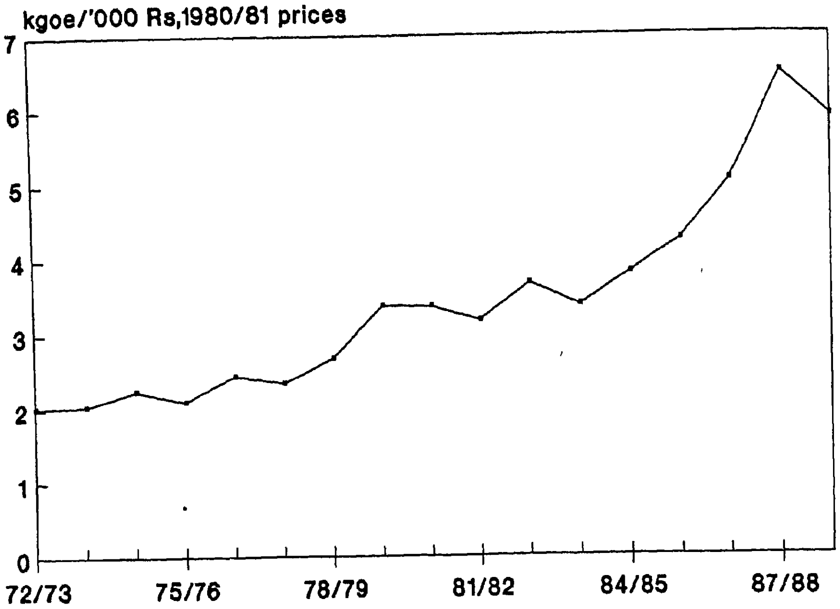
Item	Unit	1970-71	1980-81	1984-85	1986-87	1987-88	1988-89	1989-90	1989-90 (likely)	Annual rate of increase (%) between 1980-81 & 1989-90
Area under High yielding varieties	Min.hec	15.5 (17)	43.1 (45)	54.2 (56)	55.5 (58)	56.2 (61)	54.2 (60)	60.1 (61)	63.9 (65)	4.5
Paddy	Min.hec.	5.6 (15)	18.2 (46)	22.8 (55)	23.5 (57)	24.0 (58)	22.3 (58)	25.4 (61)	27.7 (66)	4.8
Wheat	Min.hec.	6.5 (36)	16.1 (73)	19.1 (80)	19.1 (83)	19.2 (83)	19.7 (87)	20.2 (84)	20.6 (86)	2.9
Jowar	Min.hec.	0.8 (5)	3.5 (22)	5.1 (32)	6.1 (39)	5.5 (35)	6.0 (38)	6.1 (41)	7.4 (50)	8.7
Bajra	Min.hec.	2.1 (16)	3.7 (32)	5.2 (49)	5.0 (47)	5.3 (47)	4.0 (46)	5.9 (49)	5.4 (45)	4.3
Maize	Min.hec.	0.5 (9)	1.6 (27)	2.0 (34)	1.8 (31)	2.2 (37)	2.2 (40)	2.5 (42)	2.6 (44)	5.6

Figures in brackets indicate the percentage of high yielding varieties to total area under respective crop.

Another contributing factor to the increased use of energy in the agricultural sector has been the high incidence of droughts since the mid 60s. Thus, while the country has experienced drought conditions in almost all the years from 1965 to 1974 barring 1967, 1970 and 1973, the 80s have experienced near severe drought conditions in 1982 and 1985 and a severe drought in 1987 which affected nearly 50% of the total geographical area of the country.

All the above factors have contributed towards the growing energy intensity of agriculture over the period 1972-73 to 1988-89 (Figure 1.8). It is seen that energy intensity in

Fig.1.8 COMMERCIAL ENERGY INTENSITY IN THE AGRICULTURE SECTOR



agriculture has increased by more than a factor of three this period.

While the estimates of diesel consumption by agriculture a not well recorded, information on electricity consumption i agriculture sector is well documented. An analysis of th energy consumption pattern reveals that agriculture is highl dependent on electricity to meet its commercial energ requirements (Figure 1.9). In the period 1980-81 to 1988-89 the share of electricity in total commercial energ consumption by the agricultural sector has increase significantly from 75% to 90%. A large part of this shift i commercial energy demand from oil to electricity has resulte from the decision taken by several State Governments to hav a flat tariff on agricultural pumpsets based on horse power rating of the pumpsets. Not only has this resulted in an inefficient and wasteful usage of electricity - accountin for some part of the increased share of agriculture in electricity consumption - but also in a misrepresentation of the actual connected loads of agricultural pumpsets.

Figure 1.10 gives an indication of the extent to which farm mechanization has progressed over the period 1951 to 1990. While, the number of tractors per lakh hectares of gross crop area has gone up by a factor of 100 over this period, the number of oil engines has gone up by a factor of 50 while that of electrically operated irrigation pumpsets/tubewells have gone up by a factor of over 250.

FIG.1.9 CONSUMPTION OF COMMERCIAL ENERGY IN THE AGRICULTURE SECTOR

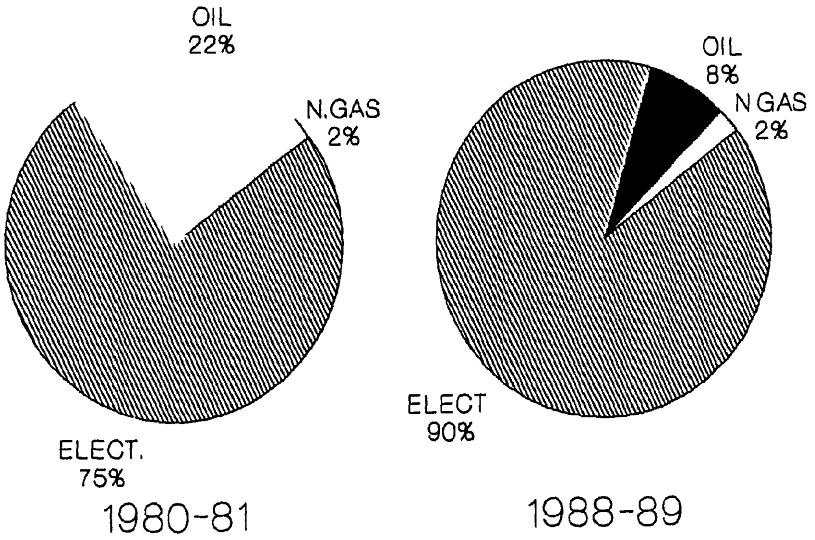
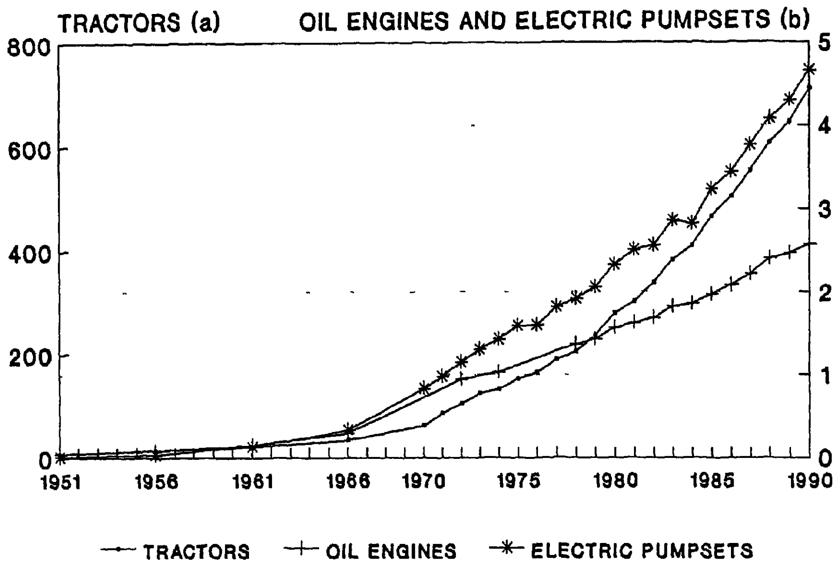


FIG.1.10 FARM MECHANISATION



(a) PER LAKH HECTARES OF GROSS CROPPED AREA
(b)PER HUNDRED HA OF GROSS CROPPED AREA

The number of pumpsets that have been energized have gone up from a level of 21,000 in 1950-51 to over 7.6 million in 1988-89. The Central Electricity Authority of India claims that the number of villages electrified have increased from 0.5 per cent of the total number of villages in 1950-51 to 78.4 per cent of the villages in 1988-89. However, very little information is available on the actual number of households that use electricity in the rural areas.

1.3.2 Industrial Sector

The energy intensity of the industrial sector depends on the size of the industrial sector in relation to total economic activity; the relative shares of energy intensive and less energy intensive industries; and the efficiency of the technologies employed. Value added by the manufacturing sector in India forms about 21 per cent of GDP. However, this sector consumes more than half of total commercial energy consumed.

While industry is one sector that uses almost all forms of energy, the main energy sources that are being consumed by the industrial sector include electricity, coal, fuel oil, diesel oils, naphtha and, in recent years, natural gas. Table 1.3 summarizes the energy consumption in industries over the period 1970-71 to 1987-88. It is seen that captive (self) generation has a significant contribution in the total electricity consumption of this sector.

Table 1.3 : Energy Consumption in Industry

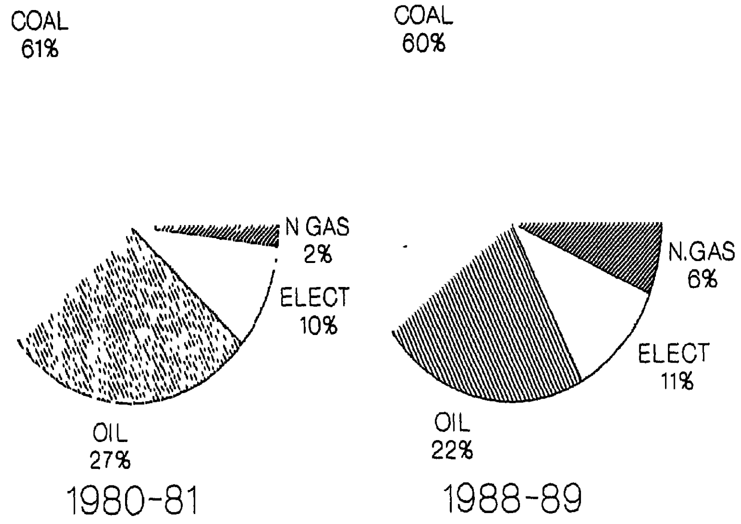
	1970/71	1976/77	1982/83	1984/85	1985/86	1986/87	1987/88
Electricity purchased from utilities (GWh)	29579.1	41605.6	53063.8	63019.3	66980.1	71495.9	77104
Self generated electricity (GWh)	5347.2	7240.3	9989	12303	12997.3	N.A.	N.A.
Total electricity consumption (GWh)	34926.3	48845.9	63052.8	75322.3	79977.4	N.A.	N.A.
Fuel oils cons. (b) ('000t)	N.A.	3641(c)	4304(d)	4458(d)	4702(d)	5125(d)	5007(d)
Naphtha cons. ('000t)	N.A.	2183	2958	3125	3106	3249	2852
HSD cons. ('000t)	N.A.	610(e)	876	1122	1263	1293	1500
LDO cons. ('000t)	N.A.	877(e)	302	377	397	433	520
LPG cons. ('000t)	N.A.	52	70(f)	99(g)	140(g)	144(g)	243(g)
Coal cons. (h) (million t)	N.A.	55.8	67.3	72.2	75.03	70.02	

a. Provisional
b. Furnace oil, LSHS and HHS. Excludes fuel oils used for power generation.
c. Includes consumption of DGS&D.
d. Excludes consumption of DGS&D.
e. Includes HSD/LDO used for power generation, plantation/food processing, agriculture retail trade and DGS&D sectors.
f. Includes LPG used in commercial sector only.
g. Includes LPG used in commercial sector too.
h. Includes coal used for making hard coke, but which is not used in the steel industry.

Source: TERI's Energy Data Directory and Yearbook (TEDDY) 1989

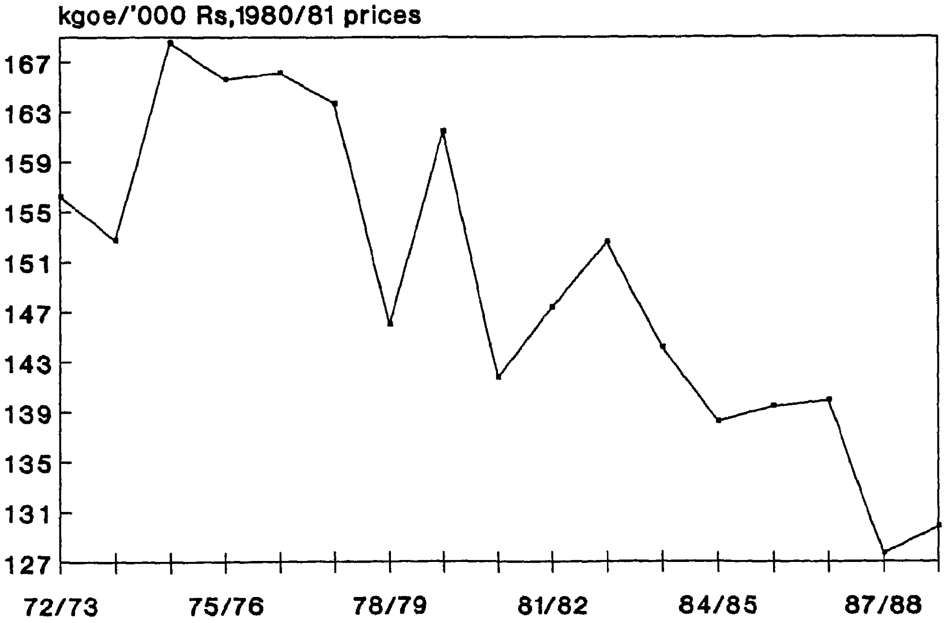
Figure 1.11 gives an indication of the shifts in the shar of specific fuels being consumed by the industrial secto Natural gas is seen to be playing a much larger rol substituting for oil consumption in the eighties while th share of coal and electricity have remained more or les constant.

FIG.1.11 CONSUMPTION OF COMMERCIAL ENERGY IN THE INDUSTRIAL SECTOR



The energy intensity of industry has declined in the 1980s from a level of about 141 kgoe per thousand rupees to a level of about 130 kgoe per thousand rupees in 1988/89 (figure 1.12). A large part of this decline has been due to a lower rate of growth of some of the energy intensive manufacturing sectors. For example, the cotton textiles industry which experienced a growth of 2.3% per annum in the 1950s and has been more or less stagnant since then, actually registered a decline of 5.1% per annum in the 1980s. In the case of nitrogenous fertilizers, growth rates of over 18% per annum in the 50s and 60s gave way to much lower growth rates of 14% and 10.7% in the 1970s and 1980s respectively. The refractory sector which grew at 10.1% in the 1950s registered a negative rate of growth in the 1970s and a 3.6% rate of growth in 1980s.

FIG.1.12 COMMERCIAL ENERGY INTENSITY IN THE INDUSTRIAL SECTOR



Similarly, finished steel production grew at 9.8% in the 1950s and then has experienced a decline in this rate of growth to 5.3% in 1960s and 3.8% since then. Another energy intensive industry which has exhibited a significant decline in its rate of growth has been the aluminium industry which has shown growth rates of 16.8%, 25.4%, 1.8% and 9% in the 4 decades since 1951. The average cumulative annual rate of growth of the manufacturing sector in the 1980s has been a little over 8% which is larger than the rates of growth experienced by most of these energy intensive industries. There has thus been a shift in the mix of industrial production towards less energy intensive industries which has resulted in a decline in the energy intensity of the industrial sector as a whole in the 1980s.

This phenomenon has also been contributed towards by a shift to more energy-efficient methods of production for example in the cement and fertilizer sectors. In the case of cement industry, there has been a fairly rapid shift from the wet production technology to the dry production technology particularly in the 1970s and 80s. Table 1.4 gives the percentage mix of total clinker capacity according to these production technologies from 1950 onwards. The last column in the table gives total energy requirements per tonne of cement output for these technologies.

Table 1.4 : Distribution of cement production by technology

Process	% of the total clinker capacity						Energy Re ment Gcal tonne
	1950	1960	1970	1981	1984	1988	
Wet	97.3	94.4	69.5	56.0	36.98	26.0	1.69
Dry	0.0	1.1	21.5	36.20	59.76	74.0	1.09
Semi-dry	2.7	4.5	9.0	7.80	3.26	0.0	1.22

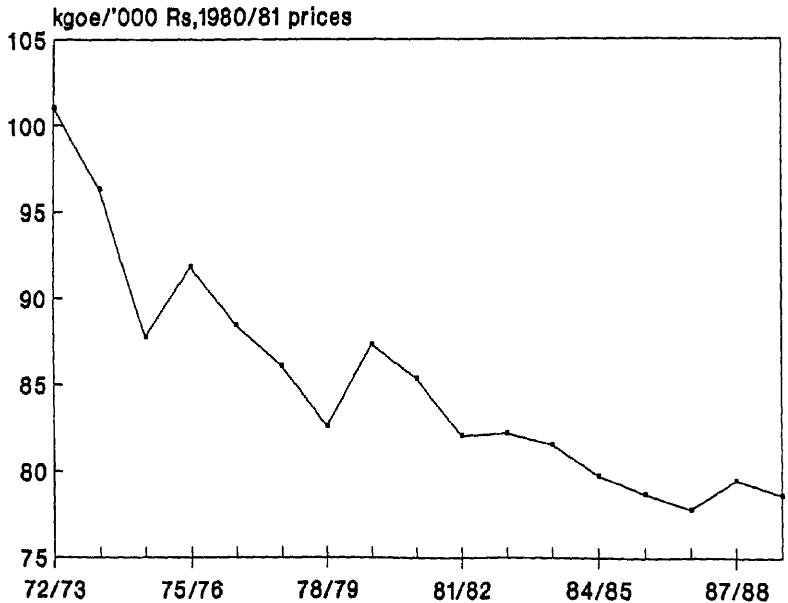
Even in the case of fertilizers a perceptible shift towards more efficient technologies can be noticed in the 1980s wherein the share of nitrogenous fertilizer capacity based on natural gas as feedstock has increased from 46.3% to 51.5% while the share of capacity based on fuel oil and coal has gone down from 23.2% to 17.9%.

In the case of steel making processes in India, one can again see a trend towards more efficient technologies of production. The share of open hearth process has declined from 48% in 1983-84 to 38% in 1986-87 while that of LD-converters has increased from 28% to 35% and electric furnaces from 24% to 27% respectively in the same period.

1.3.3 Transport Sector

Transportation requirements of any country are highly dependent on the overall growth of the economy. However, the energy consumption in this sector is also related to the relative shares of the different modes of transport and the fuel efficiency of each transport mode. Though in quantitative terms energy consumed in this sector has increased from 13.5 mtoe in 1972/73 to 26.055 mtoe in 1988/89, the intensity of its use has come down significantly as brought out in figure 1.13. This decline in intensity is largely the result of a shift away from steam locomotion to diesel engines and electric locomotives and not due to technical improvements which enhance energy efficiency. The operating intensity of various modes of traction (Table 1.5) clearly indicate that diesel traction is more efficient by a factor of 20 while electric traction efficiency is higher by a factor of 60 over steam traction for passenger movement. In the case of freight movement the disparities are marginally lower for diesel traction whereas electric traction is more efficient by a factor of about 26.

Fig.1.13 COMMERCIAL ENERGY INTENSITY
THE TRANSPORT SECTOR



•For computing energy intensity GDP of transport/storage & communication is taken.

Table 1.5 : Energy intensities of passenger and freight movement

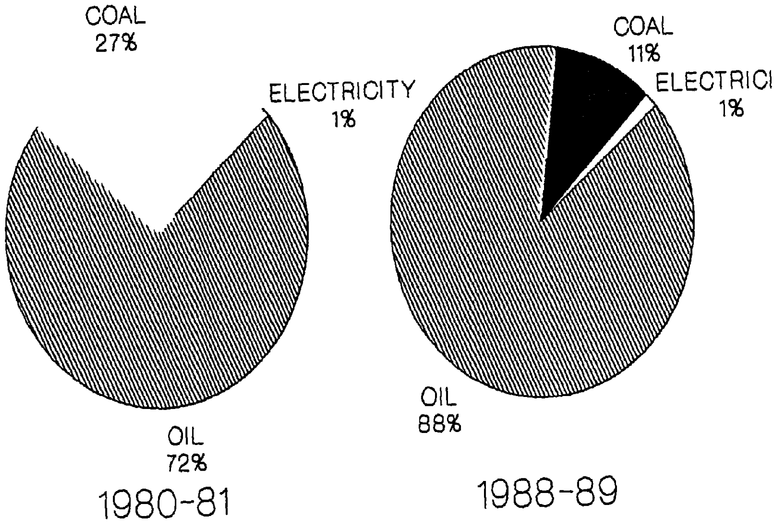
	Passenger (BTUs/pkm)	Freight (BTUs/ton km)
Steam traction	2765	2765
Diesel traction	135	166
Electric traction	46	105

Source: National Transport Policy Committee Report.

This reduction has come about despite an increase in the relative share of the more energy intensive road transport. Railways have lost ground in both freight and passenger traffic - largely due to under investment in the railway system which is a constraint to its ability to compete effectively with the more flexible road transport. Thus, the share of railways in total freight traffic moved has declined from a level of 80 per cent in 1951 to about 65 per cent in 1970-71 and further, to a present level of about 49 per cent. With respect to passenger movement the share of railways has declined from 62.2 per cent to 33 per cent and further to a current level of a little over 20 per cent over the same periods.

As mentioned earlier the main transportation fuels are mogas, aviation turbine fuel, high speed diesel, coal and electricity. With a rapid phasing out of steam locomotion and limitations on the electrification of rail routes the share of the petroleum fuels has been increasing rapidly as brought out in figure 1.14. An analysis of the consumption of these three petroleum-based transportation fuels reveals that

FIG.1.14 CONSUMPTION OF COMMERCIAL ENERGY IN THE TRANSPORT SECTOR



the rate of growth in diesel and mogas are significantly high. In addition to the shifts from rail to the road sector, within the road sector as well as there has been a decline in the shares of the more efficient public (mass) transport facilities in relation to private (passenger carrying capacity of less than 5) modes of transportation. Table 1.6 gives the long term rate of growth in the registered number of different types of vehicles as well as more recent trends in the same.

It is seen from this table that the fastest growing modes of transportation in recent years have been the two wheelers, followed by cars, jeeps and taxis. It is this rapid growth in the private modes of transportation that has resulted in the high rate of growth of demand for mogas - which India has now started importing at the margin.

Table 1.6 : Rate of growth of registered vehicles in India

	Rate of Growth	
	1950/51-1985/86	1980/81-1987/88
Two wheelers	16.6	18.9
Cars, Jeeps and Taxis	6.9	9.1
Trucks	5.6	9.8
Buses	18.2	7.7
Other vehicles	10.4	10.1

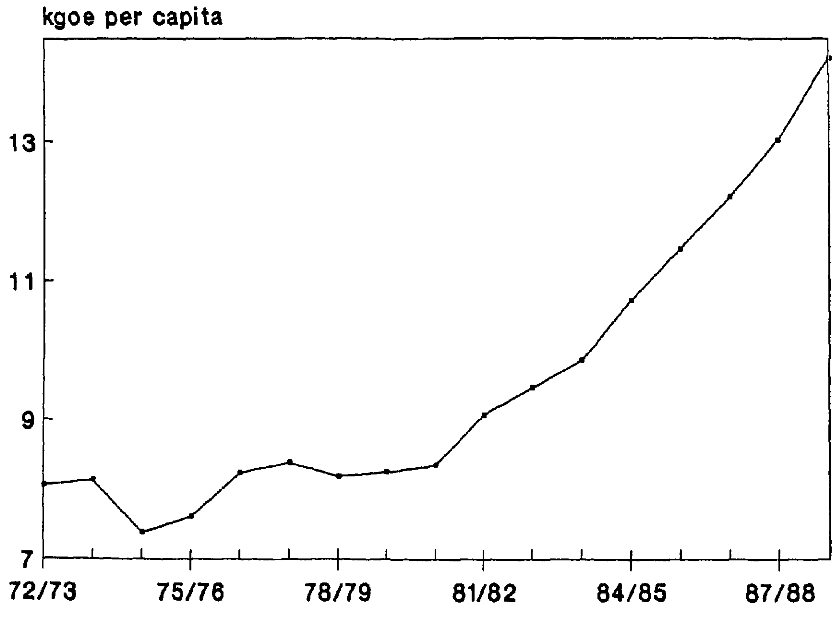
Source: TEDDY 1989

1.3.4 Household Sector

The household sector is the largest consumer of energy, accounting for over half of the total energy consumption if one was to take into account the biomass forms of energy as well. The major end-uses for which energy is being demanded are cooking, lighting and water heating. A number of studies have shown that energy consumption is related to the income levels of the population. At low income levels, cooking accounts for the bulk of all energy consumed in the household sector. As incomes increase the share of other end-uses, relating mainly to the use of electrical appliances, increases rapidly. Thus, the quantum of energy consumed as well as the type of energy consumed in this sector is closely tied to income growth. All studies of household energy consumption have shown that a rise in income levels are accompanied by a switch from non-commercial fuels to more convenient and more efficient commercial fuels such as kerosene and LPG.

Given the growth in total population; reductions in the population below the poverty line; increased urbanization; and the burgeoning population in the middle income category, the per capita energy consumption levels in the domestic sector have increased rapidly from a level of 8 kgoe in 1972-73 to a level of 13 kgoe per capita in 1988-89 (Figure 1.15). The share of the domestic sector in electricity consumption has increased very rapidly as also the consumption of petroleum products, in particular LPG and Kerosene.

FIG.1.15 COMMERCIAL ENERGY INTENSITY IN THE RESIDENTIAL SECTOR



The growth in domestic electricity consumption is reflected by the increase in growth of electricity using domestic appliances. This is brought out in Table 1.7 below.

Table 1.7 : Ownership pattern of electrical household devices (Number per thousand households)

	Electric Lamps	Electric Fans	Refrigerators	TV Licenses
1951	200	2.8	12	--
1960	446	11.9	14	--
1970	1018	14.0	63	5
1980	1712	29.5	228	231
1983	2802	32.5	352	406

Source : Standard of living of the Indian people, CMIE

Section 2 : Main Issues in the energy sector

The issues here are restricted purely to those relating to energy demands.

2.1 Energy shortages

One of the major challenges that has been facing the Indian economy has been the persistent shortages in meeting the demand for energy. Although large shares of various Plan outlays have been allocated to the energy sector - in particular power - since the first five year plan onwards , supply has not been able to keep pace with the rapid growth in demand. The power sector has been estimating shortages in demand for energy at almost 10% per annum over several plan periods. Table 2.1 summarizes the shortages in the country for the periods 1984-85 to 1988-89.

Table 2.1 : Power shortages in recent years

Region	1984/85	1985/86	1986/87	1987/88	1988/89
Requirement	155432	170746	192356	210993	202711
Availability	145013	157262	174276	187976	187038
Surplus (+)/ Deficit (-)	(-)10419	(-)13484	(-)18080	(-)23017	(-)15673
Surplus (+)/ Deficit (-)	(-)6.7	(-)7.9	(-)9.4	(-)10.9	(-)7.7

Source : TEDDY 1989

While some estimates are available on shortages in electricity supply, a major problem has been acknowledged to be the shortages in capacity to meet demand during peak periods. This has resulted in power break downs and power cuts in the peak demand periods as well as poor quality of supply largely in the form of low voltages due to excess load on the system.

Shortages in the demand for oil are made up through the import of petroleum products which therefore act as a good indicator of energy shortages not only relating to oil but also reflecting to a certain extent the shortages that are felt in the demand for coal as a substitute fuel as well as electricity. Shortages in electricity supply are made up through oil and coal - based captive generation.

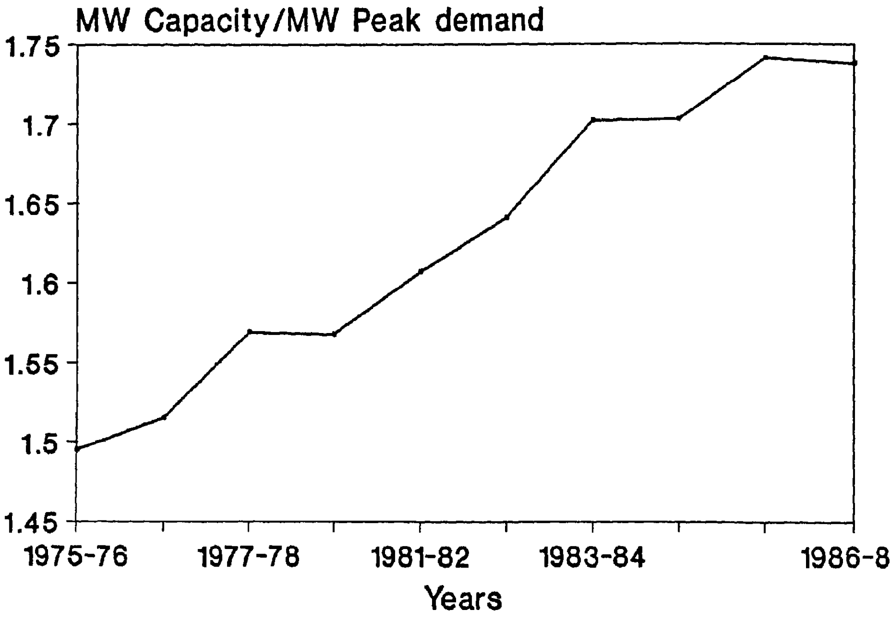
In the case of coal the shortages are not so much in quantities than in the quality of coal that is required. Thus very often industry finds itself using coal of a much lower quality than the equipment is designed for resulting in significant productivity losses.

2.2 Peak electricity demands

A problem that is facing the power sector, as has been brought out earlier, is the increasing demand for power during peak load periods relative to base load demand. Figure 2.1 gives the ratio of capacity required to be set up for meeting one additional MW of demand during the peak times. It essentially reflects the increasingly sharp peak that is facing most electricity boards in the country, that is, very heavy loads experienced for very short periods of time. A large part of the demands during these periods -

occuring either between 18.00 and 22.00 hours or in so cases in the morning hours of the day - are attributed t lighting, water heating or television loads.

FIG.2.1 RELATIONSHIP BETWEEN CAPACITY AND PEAK



2.3 Coal demands on transportation

A major problem in relation to coal demands is the declining quality of coal. This alongwith the growing spread of industries has resulted in increasing transportation demands for usefully consuming the same quantities of coal based energy - more so due to the fact that a large part of the resources are concentrated in the eastern parts of the country. The average lead distances of coal moved have increased from a level of 581 km in 1970-71 to 656 km in 1987-88 (Table 2.2).

Table 2.2 : Average lead distance of freight moved by coal (km)

Year	Distance
1970/71	581
1973/74	562
1976/77	575
1979/80	570
1982/83	582
1985/86	634
1986/87	654
1987/88	656

Source: TEDDY 1989

2.4 Oil imports and the middle distillate crisis

Crude oil exploration and production received a boost following the first international oil price shock of 1973-74 after which large sums of resources were pumped into the oil sector to reduce our dependence on oil imports. The discovery of Bombay High in 1976 largely contributed to containing the growth in oil imports. However with the stagnation in production from Bombay High from the mid - eighties, oil imports have risen rapidly once more. With petroleum product demand increasing at 8 - 10 percent per annum in recent years, India's oil import dependency has increased to as high as 45 percent in 1989-90.

The products that have been contributing to the rapidly increasing demand for oil use have been the middle distillates and more recently other domestic sector light fuels such as LPG and mogas. The fact that the demand for middle distillates has increased fairly rapidly is brought out by figure 2.2 which gives the trends in sales of petroleum products - middle distillates vs others.

Figure 2.3 gives the consumption profile for light distillates, middle distillates and heavy ends. While production and consumption of heavy ends match closely (including domestic petroleum production consumption based on imported crude oil), large divergences are seen in the case of middle distillates. Although light distillate production is seen to be higher than consumption of light distillates as a group, this conceals the fact that in recent years India has started importing motor gasoline to meet its demand. A break up of middle distillate consumption by its two major components -kerosene and HSD - reveals that while there have been fluctuations in the shortage of diesel, shortages of kerosene have been higher (Figure 2.4).

Natural Gas

Natural gas is a relatively new entrant in the energy sector in India. Before the discovery of free gas fields at South Bassein, production of natural gas was largely in the form of

FIG.2.2 TRENDS IN SALES OF PETROLEUM PRODUCTS

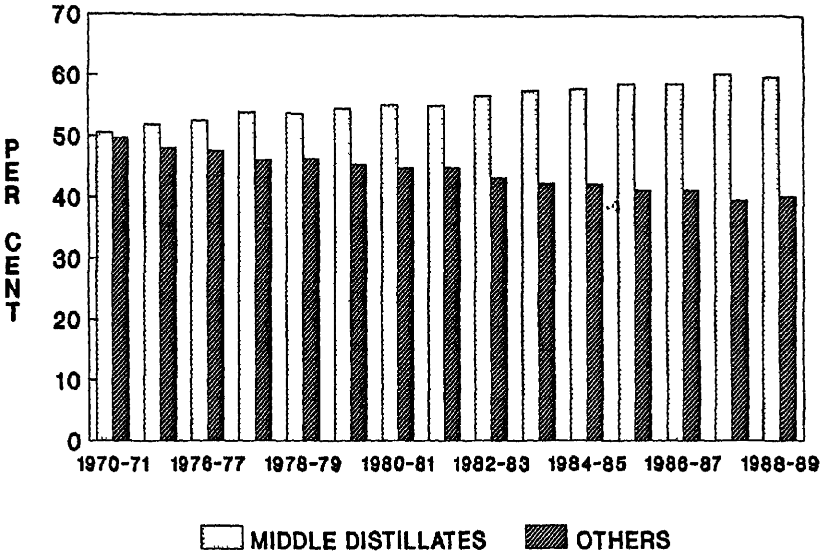
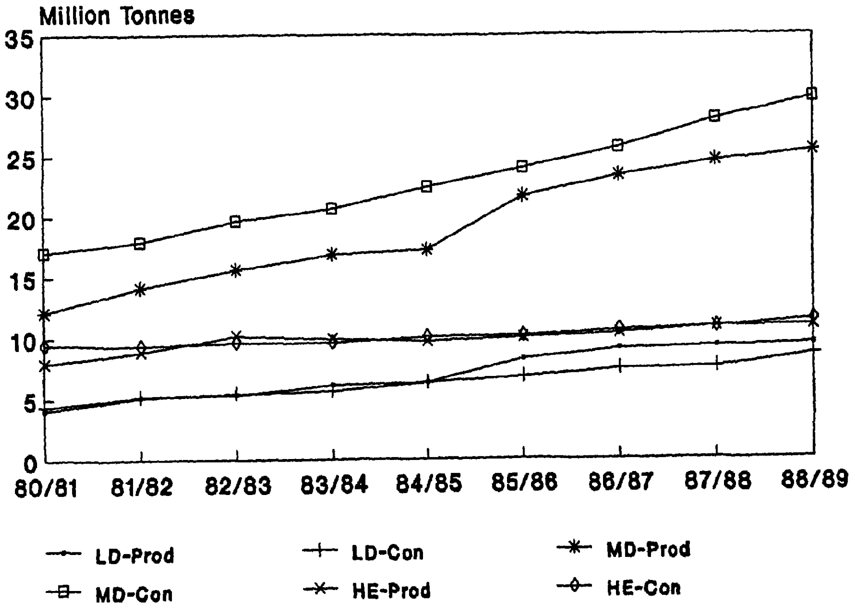


FIG.2.3 Petroleum Product Profile



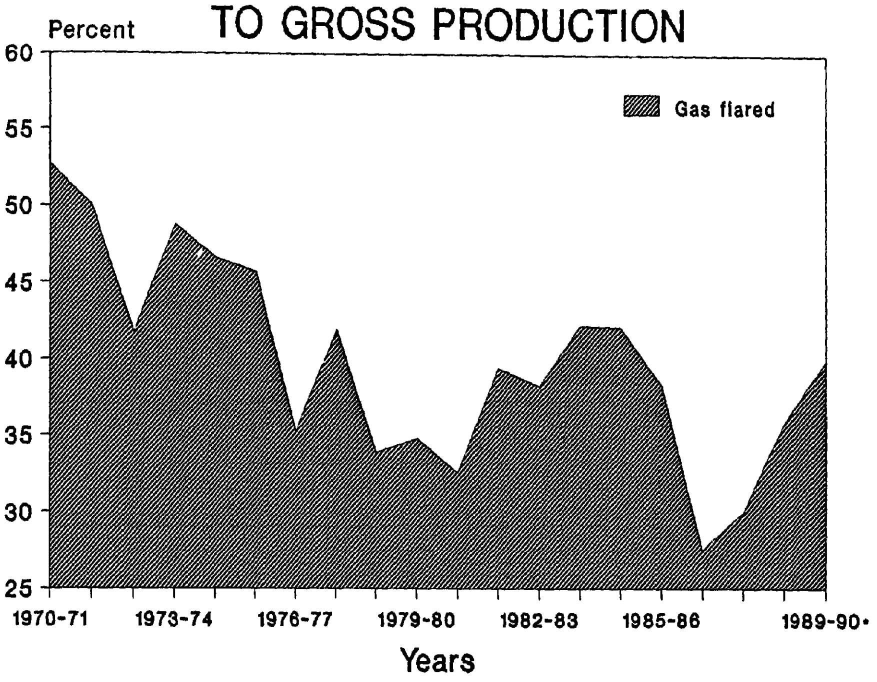
associated gas and was linked to crude oil production. Unfortunately, little attention had been paid to the development of markets for natural gas and as a result up to the middle of the 70s, 45-50 per cent of natural gas that was being produced was flared (Figure 2.5). The two oil price shocks and the resulting crunch on both foreign exchange and thereby crude oil imports led to increasing pressures to develop natural gas as a resource. Unfortunately, long delays in the implementation of downstream utilisation facilities has resulted in the non-upliftment of available natural gas resources. This combined with higher gas to oil ratios in Bombay High have led to nearly 40 percent of the gas being flared again.

2.5 Inefficiencies in the utilisation of energy

The existence of large scale inefficiencies in energy consumption are partly responsible for the increasingly high energy intensities of the economy. Some examples of such inefficiencies are given below.

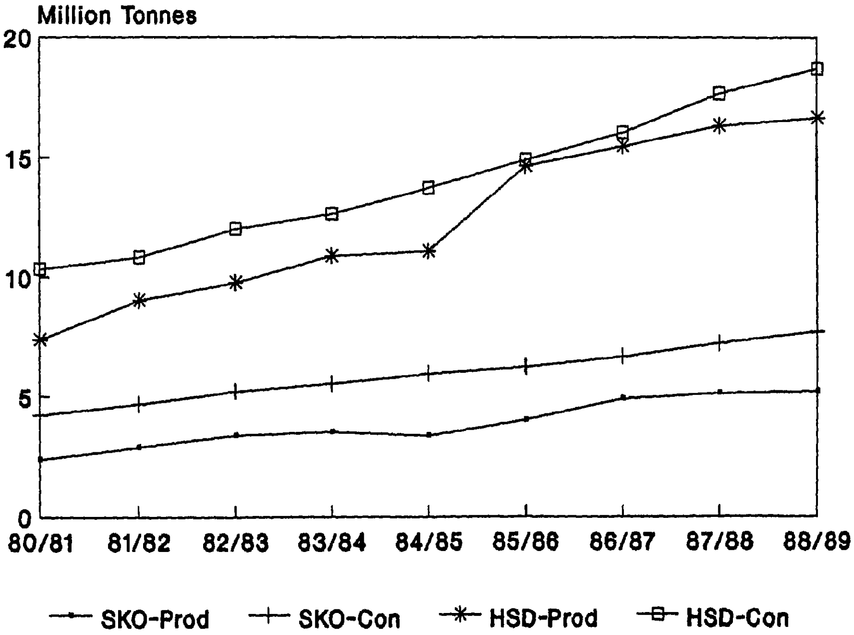
Considerable scope for energy savings exists in the irrigation sector wherein pumpset efficiencies have been found to be as low as 50% in the case of both diesel pumpsets and electric motors, as against the optimum efficiency of 70-75%. In a study financed by the Agricultural Refinance and Development Corporation and carried out in 5 states of the country, the following reasons were put forth for the low efficiency cf pump sets.

FIG.2.4 NATURAL GAS FLARED RELATIVE TO GROSS PRODUCTION



• Estimated

FIG.2.5 MIDDLE DISTILLATE PROFILE



1. Pumps not properly selected	96
2. Proper prime movers not selected	22
3. Pumps not properly installed	68
4. Pumps not properly operated	36
5. Pumps not properly maintained	23
6. Oversize prime movers used :	
Oil engine	28
Electric motors	0.35
7. Pumps installed at higher suction lifts resulting in cavitation	49
8. Footvalve losses exceed 0.4 metres	23
9. Suction side losses exceed 7.5% of static suction lift	93
10. Average overall efficiency :	
a) Electric motor driven pumpsets	41
b) Oil engine driven pumpsets	10.25
11. Average efficiency of the pump :	
a) Electric driven pumps	52
b) Oil engine driven pumps	49.98

The estimated annual savings on fuel and power consumption works out to around Rs. 255 crores assuming 1000 hours of operation for about 60 lakhs pump sets if the recommendations of the study are implemented.

A nationwide survey of industries conducted by the Petroleum Conservation Research Association revealed that in the short term there is scope for conservation to the extent of 18% through good housekeeping measures alone. The potential savings in some of the major industries is given in Table 2.3 below.

Table 2.3 : Annual savings potential as % of energy bill

Industry	Without significant Investments	With significant Investments	Total
Foundries	15	10	25
Aluminium	8	2	10
Cement	4	4	8
Fertilizer	12	2	14
Paper	6	12	18
Glass	5	5	10
Textiles	10	5	15

Source : Energy Conservation

The Inter-Ministerial Working Group on Energy Conservation envisaged a savings potential up to 25% and estimated that an investment of Rs. 3600 crores towards energy conservation measures would lead to an annual savings in energy worth Rs. 1925 crores.

Lighting contributes significantly to household energy demands and this share of lighting is expected to increase in the future as a larger percentage of the rural population, have access to electric lighting. TERI has estimated the percentage savings in demand and energy that could result in the use of energy efficient lighting by domestic consumers in Delhi at anywhere between 10 to 60% dependent on the type of new technology adopted.

2.6 Energy Pricing

Energy prices are administered in India and therefore do not reflect the true opportunity cost to the country. In fact in some cases the extent of subsidy on the product limits resource generation which in turn limits investments to meet the growing demand. This has been the case in the coal sector and also explains partly the power shortages in India.

Given the substitutability of fuels it is very important to adopt an integrated approach for pricing of fuels. For instance soft coke, kerosene and LPG are used for cooking, coal and fuel oil in industrial boilers and diesel and electricity for rail traction. There is an urgent need to use pricing as a tool to encourage an appropriate fuel mix for the Indian economy. More details on the same are given in the following section.

Section 3 : Evaluation of Government policies and strategies relating to the energy sector

The first exercise undertaken by the Government of India to arrive at a comprehensive plan for the energy sector was the setting up of the Energy Survey of India Committee in 1965. Prior to that, various five year plan periods did mention briefly the need to develop the power sector in the country. The first five year plan mentioned that the immediate priority in initiating the process of development would be for agricultural development including irrigation and power. In this time period the share of traditional biomass fuels was very significant (at about 85%). The second five year plan recognized that sectors like power and transport have an important place in the preparation of long range investment plans. This was based largely on the observation that the demand for power had changed rapidly in the first five year plan period.

The Energy Survey of India Committee (1965), appointed by the Ministry of Irrigation and Power, carried out the first broad survey of trends in energy demand and supply in the country. In fact, a unit was established within the Planning Commission which was concerned solely with energy problems. Elaborating on the issues this unit would address, the Committee stated, "we recommend that this unit be charged with the responsibility for the collection and organization of the statistics that are essential to any such work". Thus, this Committee focused largely on the need to set up an adequate database for the energy sector.

This was followed by the setting up of a Fuel Policy Committee in 1974 which examined in detail the issue of interfuel substitution. The focus of this Committee was largely determined by the steep hike in the price of oil in October 1973. The Committee argued, "all the uses of oil, except those in the transport sector, can be substituted for by indigenous fuels, namely, coal or coal-based energy forms. For example, in the household sector the use of kerosene for lighting can be replaced by electricity. The use of kerosene for cooking can be replaced by coal gas in the case of densely populated urban areas and soft coke in small towns and some rural areas. For lifting water, electricity becomes more advantageous, relative to diesel oil".

"Given the uncertainty regarding the level of oil prices in the future, the areas and extent of substitution of oil, by coal will have to be limited to those options whose worthwhileness remains largely unaltered for any probable variation in prices". It also recommended that the country's coal reserves were its prime resource of energy and it was necessary to develop coal mining methods which would lead to extraction of a larger percentage of coal. Greater attention needed to be paid to the development of transportation infrastructure to facilitate the movement of coal from the point of production to the point of consumption.

The Fuel Policy Committee was succeeded by the establishment of a Working Group on Energy Policy in the year 1979. The setting up of this group was again prompted by the realization that there can be no guarantee of steady supplies of oil to any importing country. The group realized the limitations to the pace at which supply could be increased and stated that all efforts should be made within the country to secure a low growth of energy consumption to optimize the fuel utilization pattern. The group was of the view that energy policy making should be a continuous exercise and not one to be undertaken at periodic intervals. The group also pointed out that while all efforts should be made to conserve resources of conventional fossil fuels by more efficient production and utilization measures, there is a need to rely increasingly on renewable sources both of the traditional type based on biomass and newer forms like solar and wind energy.

The 6th five year plan for the first time envisaged a comprehensive and integrated energy strategy for the country. An important factor in shaping the strategy was again the frequent oil price increases in the international market as well as the need to have decentralized energy production in the rural areas. The main elements in the strategy outlined included the following :

1. accelerated exploitation of domestic conventional energy resources
2. management of oil demand

3. energy conservation
4. exploitation of renewable sources of energy and
5. intensification of research and development for emerging energy technologies.

In 1978 the Government of India appointed a committee on power to "examine all aspects of the functioning of State Electricity Boards and central organizations engaged in electricity generation, transmission and distribution including organization structure, management practices, planning systems, efficiency of operation, financial performance, tariff structure and legislative framework and make recommendations for improving them".

The committee came out with several recommendations not only on demand forecasting, capacity planning, project formulation, operation and maintenance, tariffs etc. but also on load management, conservation and quality control. The committee recommended that for the industrial load, all states should adopt measures such as staggering off-days, high peak hour tariffs, timing of annual shut-downs for overhaul of major consuming industries so as to reduce seasonal and daily peak demand and flatten the load curve. It estimated a potential for reduction in power usage in industry of about 20% by adopting a wide range of conservation measures. For agriculture it recommended the restoring of loads, use of properly sized and efficient pumpsets, elimination of flat rate tariffs and installation of efficient transformers and capacitors. The need for appropriate peak hour pricing of domestic and commercial power and enforcement of minimum standard of efficiency was stressed.

The Inter-Ministerial Working Group,again constituted by the Government of India, submitted its report on utilization and conservation of energy in 1983. The group emphasized the need for comprehensive measures and institutional mechanisms for effective implementation of energy conservation at both the policy formulation as well as the industry and unit levels. The group suggested the creation of a revolving fund to be expanded by around Rs. 100 crores every year over a span of 10 years through the levying of energy conservation cess on industrial consumption of electricity, petroleum products and coal. A package of fiscal incentives, disincentives and punitives should be evolved to promote energy conservation. It highlighted the need to equalize prices to users in terms of energy and the introduction of differential pricing systems for freight movements of superior and inferior coals and to encourage interfuel substitution in industry through price changes. It also recommended that the adoption of cogeneration systems should be made mandatory in certain industries.

The Advisory Board on Energy set out in 1984 to make essentially energy demand and supply projections for the next 20 years. The Board laid a high priority on meeting the requirements of households. It advocated the use of improved chulhas which would have an impact not only on reducing the consumption of wood but also on reducing the smoke levels emitted. Demand management too needed to be accorded high priority. The group felt that energy intensity of the economy needs to be reduced by improving the efficiency with which energy is utilized and promoting interfuel substitution. While the various committees, working groups and five year plan documents have stressed on several measures to bridge the gap between energy supply and energy demand, it is obvious that there has been little or no implementation of these measures and the gap between demand and supply continues to increase. A large part of the failures to implement the various measures can be attributed to the fact that there is no single integrated planning exercise that has been undertaken by the country at the implementation level, as also the lack of a political will to introduce some of the major changes that are required - particularly those relating to the distorted pricing structure that exists in the present economy.

The following chapter will identify some of the possible solutions to the energy problem. There will, of course, be some overlap between the solutions presented here and those recommended by previous studies but that will only serve to highlight the fact that there is an urgent need to take action on some of these measures.

Section 4 : The need for further action

To address briefly the main issues facing the energy sector from the demand side would entail the following action:

(1) Managing electricity demand during peak demand periods

(2) Curbing the rate of growth in petroleum product consumption

(3) Substituting for oil usage particularly for low quality uses with coal

(4) Developing markets and infrastructures to promote the utilization of natural gas

(5) Promoting the use of renewable energy forms

(6) Effecting efficiency improvements across all consumer sectors

(7) Promoting the use of more efficient modes of transportation through a series of incentives.

Since this report is essentially analyzing the demand side of the energy picture, it will not address the supply options for enhancing availability of energy. On the demand side measures that need to be adopted for proper energy planning include an efficient pricing system, promoting efficiency in use of energy and also interfuel substitution in certain sectors of economy.

4.1 Energy pricing

A sound energy pricing policy is the key to efficient use of energy not only in terms of utilization of resources but also in sending the right market signals to the consumers. It also helps in mobilizing the resources required for sustaining production of energy. Energy pricing in India has historically and even currently been dictated by social and welfare considerations rather than efficiency and resource considerations. Several of the documents reviewed above have pointed out the need to have a more rational pricing structure that would take into account the cost of supplying energy and also ensure a certain rate of return on energy production. The 6th plan had emphasized the need for developing a pricing structure which would reflect the true costs of energy supply including an adequate rate of return and transportation costs, curbing excessive energy use and promoting conservation of scarce fuels. Despite repeated pleas to set right the structure of energy prices, the political will required to make these changes has been lacking. As a result tariffs that are charged from the consumers of electricity are almost always well below the marginal cost of supplying electricity, and in some cases below the average cost of production itself.

In the case of the agricultural sector, there has been a trend towards establishing flat rate tariffs which has gone against the recommendations of almost all the committees that have looked into the pricing issue. This is one of the main factors that has promoted the inefficient use of electricity in the rural areas.

In the case of oil, prices of kerosene and high speed diesel have been kept artificially low for reasons mentioned above leading to disproportionately high demands for these two petroleum products. The Government is reluctant to increase the price of kerosene which is the sole commercial energy form that is accessible to the poorer sections of the society. Prices of high speed diesel, therefore, also have to be kept low to avoid adulteration of diesel with kerosene. Another reason for low diesel prices is the assumption that it could make the use of public transportation much more economical. Unfortunately, these price incentives have not really served their purpose - kerosene which has been consumed in the rural areas is used largely for lighting purposes as against cooking and in the urban areas kerosene consumption has benefitted the lower middle income class people rather than the slum dwellers who would really need the subsidy. Due to relatively low price of diesel, in contrast with petrol, a large number of private vehicle owners (official cars, taxis, etc.) have retrofitted their engines to use the cheaper diesel oil. In the context of power shortages, the low price of diesel has also promoted the use of diesel based captive generation sets.

Coal prices have also not reflected the true value of coal supply. Moreover, a number of public sector undertakings have not paid for coal received. As a result this sector does not possess adequate funds and is accumulating heavy losses. Prices of coal, however, have increased rather steeply in the 1980s in an effort to reflect the true cost of supplying coal. But, this may prove to be counter productive to the policy of encouraging the substitution of fuel oil and other petroleum products with coal. While several example of distortions created by the present pricing structure can be pointed out there exists us easy solutions to the pricing problem. What needs to be done is to develop an integrated pricing model that would assess the economic costs of production, refining and transportation and then arrive at a rational tax/subsidy structure that would take into account social considerations while ensuring the financial viability of energy producing sectors. The stress here should be on integrated pricing due to the large inter-substitution possibilities that exist. A particularly tricky problem would relate to electricity prices for the agricultural sector. A system of metered energy supply would need to be devised wherein the farmers would not have a significant additional burden but which at the same time would dissuade wasteful consumption.

4.2 Improving energy use efficiency

In addition to the use of pricing as a tool for promoting efficient use of energy, several other steps need to be adopted simultaneously.

In the **agriculture** sector the main enduses for which energy is demanded are land preparation and irrigation. Major fuels that have been consumed for this purpose, on the commercial side, include high speed diesel oil and electricity. Considerable scope for energy savings exists in the irrigation sector wherein pumpset efficiencies have been found to be as low as 50% in the case of both diesel pumpsets and electric motors, as against the optimum efficiency of 70-75%. There is thus an urgent need to publish technical data pertaining to selection of pumpsets, pipes and valves in local languages in order to make the farmers understand the problems better and to facilitate selection of entire pumpset systems. Rigid specifications need to be insisted upon regarding the quality of pumpsets built by the various manufacturers. The manufacturers should furnish full technical literature on the pumps, including performance curves showing efficiency at different site conditions.

While improvements in the efficiency of the pumping system and the pumpset as a whole provide a direct means of energy savings in the agriculture sector, it is also possible to explore paths of low energy intensity in agricultural production. It must be realized that energy intensive irrigation based agriculture cannot alone meet the challenges on the agricultural front. This is substantiated by the fact that even after the full irrigation potential of the country of around 113 million hectares is exploited, about 70 million hectares of arable land would still be dependent on rainfall. Thus, the Government of India needs to provide adequate attention to dry land farming not only to reduce commercial energy inputs into agriculture but also to improve the productivity of these rainfed areas.

Several means have been identified for improving energy use efficiency in the industrial sector. Short term measures include modifications in operating and maintenance procedures which required little or no investments. Medium to long-term measures include complex and extensive process changes that would involve redesigning of plant and large investments. Energy conservation measures have been generally grouped under the following heads :

1. House keeping and operational improvements
2. Thermal system improvements
3. Electrical system improvements
4. Waste heat recovery
5. Cogeneration and
6. Process modification

Several factors contribute to the fact that energy conservation and demand management have not become areas of priority action in the country. As mentioned in the previous chapter the Government of India is providing several incentives for energy conservation but the response to these incentives has been rather poor due to the following reasons:

1. attitudinal rigidities
2. non-involvement and commitment of top management
3. lack of awareness
4. inadequate dispersion of energy audits
5. capital constraints
6. loans not being provided at sufficient concessional levels
7. a perception that focus on expansion and diversification would yield higher rates of return than energy conservatio
8. non-availability of efficient equipment/devices to promote efficiency
9. lack of an institutional set up

The strategies and policy measures that could be taken up to bridge this gap are briefly listed below :

1. The incorporation of environmental costs in the cost benefit analysis of specific conservation projects may tilt the balance in favour of energy conservation measures in addition to having a favourable impact on the general environment. Detailed case studies on some of the energy intensive industries exhibiting large potential for conservation should be developed.
2. Liberal fiscal incentives should be provided for energy conservation projects. These incentives should be worked out by involving the concerned industries in the debate and ensuring their co-operation from the start.
3. Soft loans at the rate of 6-8% should be made available.
4. Many prices of equipment/instruments required for energy savings are not manufactured in the country underlining the need for devising suitable policies to encourage their manufacture. Again a detailed analysis needs to be carried out here on identifying such equipment, assessing its market potential and evolving strategies for adoption.
5. An urgent need to create an energy conservation organization at the national level which would engage itself in areas relating to training, energy audits, data base and publicity.
6. Adequate support needs to be provided for research, design and development work relating to conservation technologies.

The Bureau of Indian Standards needs to specify energy efficiency standards for various equipments relating not only to the industrial sector but also to all other sectors of the economy. In doing so it should make use of studies identifying major end-use energy requirements and the demands they place on the energy sector.

Another very attractive option for promoting efficient use is the combined generation of heating power in the industrial sector. There are several major energy consuming industries in the country where the cogeneration option would prove to be extremely economical and measures need to be taken to encourage the use of this technology. While it makes economic sense to invest in cogeneration technologies, in the event that this change does not match with the priorities of individual industries, regulatory action should be taken to enforce the use of such technologies in the industrial sector. While an international team had assessed the potential for cogeneration in the Western parts of the country, the Indian perception is that this is a highly exaggerated statement of potential. Therefore to start with a realistic estimate of the potential needs to be worked out and a cost-benefit analysis carried out for specific sectors.

A detailed **transport** policy for the country sticks out like a sore thumb by its very absence. This has been made amply evident by the shifts in modes of transportation from railways to the road sector and within the road sector to the highly inefficient private modes of transportation. The approach that has been followed by the Government of India so far has been extremely short sighted and bold steps need to be taken to reverse the energy intensive trends that are being currently followed.

Adequate investments need to be made in the railways to increase both its carrying capacity as well as to reduce the turn around time of wagons. Sectors need to be identified that would have a sufficient density of traffic to support the electrification of such routes. In the road transport sector it is of extreme importance for the Government to explore practical and feasible options to promote public transportation, even if in the form of tramways. While it is encouraging that the Government is considering options such as the mass rapid transport system for Delhi such options may prove to be extremely expensive both in terms of time and resources.

Even on the private modes of transportation, there are several steps which the Government can undertake. Some of these are listed below ·

1. the setting up of model depots for checking energy efficiency of vehicles
2. ensuring a proper maintenance schedule for these vehicles
3. phasing out of cars with engines as old as 30-40 years
4. improving the quality of roads and taking measures for decongestion
5. ensuring proper education of drivers on the use of vehicles.

An interesting study relating to this sector would involve a comprehensive planning exercise for restructuring urban layouts and the consequent impact on transportation and the environment.

On freight transportation as well a detailed analysis needs to be carried out on the reasons behind the shift to road based transportation and measures defined to reverse this trend. A package of incentives would have to be devised to break the inertia of moving back to the railways for transporting commodities.

The major end-uses for which energy is demanded in the **household** sector include cooking, lighting and water heating. However, minor enduses such as television loads are also gaining importance due to the fact that these come on to the systems during peak hours of the day.

A large part of the kerosene that is being consumed in the rural areas is consumed for lighting purposes in an extremely inefficient manner. On the other hand cooking energy requirements continue to be met by non-commercial forms of energy again in an extremely inefficient manner. A large scale dissemination programme on improved rural technologies (improved chulhas, biogas plants etc.) and the use of renewable forms of energy needs to be undertaken.

Lighting in urban areas becomes a very attractive area for implementing energy efficiency improvement measures as the demand for electric lighting coincides with the evening peak of most electricity boards. There is very limited data available on the contribution of electric lighting to the total system load for utilities. Two surveys carried out by TERI in Delhi and Bombay indicate that domestic lighting contributes to about 20% of the system load in South Bombay at peak time whereas it contributes to 15-20% of the connected load in Delhi. This share of lighting is expected to increase in the future. Large savings in demand and energy could result through the use of energy efficient lighting Options considered include the use of 40 watt fluorescent tubes, 20 watt fluorescent tubes and compact fluorescents. In yet another study undertaken by TERI, of a seven storeyed Government office, a savings potential of up to a third of the present energy use for lighting was estimated. Following these studies by the Tata Energy Research Institute, the Department of Power, Government of India has initiated action in trying to introduce more efficient lighting technologies and is carrying out a dialogue with various light manufacturers in the country.

Again as mentioned in the industrial sector, the Bureau of Indian Standards should take specific measures to ensure good quality of devices for household use that include, on their specification sheet, indicators of energy consumption. Lessons need to be drawn from some of the developed countries, in particular Japan, which has considerably improved efficiencies of its devices. For example the index of power consumption of refrigerators went down from a level of 100 in 1973-74 to as low as 34 in 1984-85. Similarly, for the same period the index went down to 60 in the case of colour television sets and 58 in the case of room air-conditioners.

4.3 Interfuel substitution possibilities

The need for interfuel substitution has been reiterated by different committees and working groups time and again. This was particularly true following the oil price increase of the 1970s, when a conscious effort was made by the Government of India to substitute for imported fuel oils by indigenously available coal. As brought out in chapter 4, the Fuel Policy Committee report suggested a number of areas where the use of oil could be substituted by the use of other fuels. Unfortunately, very little effort has been made in this direction.

In addition to substituting for fuel oils in the industrial sector, natural gas provides a very attractive alternative to HSD and motor gasoline (which India has started importing at the margin) in the transportation sector and to kerosene and LPG in the domestic sector. In addition to substituting oil by coal, India has several other options which it could have exploited quite easily. The two glaring examples of misuse of domestically available natural resources are the flaring of natural gas at considerable cost to the economy and the non-exploitation of the abundant renewable resources which the country is endowed with. For instance, in Bombay High, where the gas oil ratio is high, as much as 40% of the natural gas produced is flared. Values that have been attached to these losses are in the range of 1800 crores of rupees.

The Department of Non-conventional Energy Sources has, since the early '80s, been promoting the use of renewable energy technologies such as biogas and solar water heaters to meet the demands in the rural areas. However, the dissemination of these technologies is far from satisfactory and steps need to be taken to enhance the pace of dissemination of these technologies. Adequate infrastructure would also need to be set up to service and maintain these technologies. These measures would considerably alleviate the pressure on kerosene supply. To the extent that decentralized electricity generation is being promoted, considerable economies would result when one takes into account the transmission and distribution losses that occur in transmitting power over long distances.

There are several renewable energy options that could be considered for the urban sector as well. Particularly relevant would be the use of waste generated in densely populated city areas for producing either biogas or electricity for domestic use. However, further work is required in this area. Solar thermal application have also been found to be economical.

Annexure I : Energy Balances for India (1972/73 to 1988/89)

Table I.1 through I.17 show commercial energy balances for 1972/73 through 1988/89 respectively. Data for the first two years of the 1970s is rather sketchy and hence, energy balances for these years could not be structured. Owing to scarcity of reliable data on the supply and consumption of traditional fuels, production, imports/exports, stock changes, conversion losses, the net availability and sectoral consumption of only commercial energy is considered. All data are presented in common units of million tonnes of oil equivalent or mtoe (where 1 toe=10.2 million kCal). The conversion factors for the various energy fuels to mtoe are also shown in Table II.

Several assumptions have been made in compiling these energy balances. For instance, the same average calorific value of coal has been used for conversion of coal tonnage to mtoe units, although it is known that with increase in the share of open-cast mining that has taken place in the 1980s, the average calorific value may have reduced. In fact, in the 1970s a higher average calorific value of 5500 kCal/kg is used to convert coal tonnage to mtoe; it is assumed to be 5000 kCal/kg in the 1980s. This assumption is made for lack of detailed data on even the average calorific content of various grades of coal that are mined each year. Furthermore, the discrepancy between claims of quality of coal dispatched and that received by certain major consumers (particularly industry) has also not been accounted for. For the transport sector (railways), where tonnage is known the calorific content is assumed to be 4000 kCal/kg. The mtoe of coal supplied to the power sector is derived as a residual of the gross generation of electricity and electricity generated by other sources like natural gas, hydro and nuclear, diesels and fuel oil. With this information, the mtoe value of coal used in other sectors is determined.

As with coal, it becomes necessary to make some assumptions regarding calorific content of natural gas. Here, the standard norm of 856.8 toe/million cubic metres(mcm) of gas, as adopted by the oil industry, is used. However, this does not pertain to lean gas (after LPG extraction). To estimate the mtoe value of gas after LPG extraction, the product of tonnage of LPG and calorific value of LPG is subtracted from the overall natural gas mtoe value. Owing to differences in LPG extraction quantities from year to year, this procedure gives a different value each year for average calorific value of gas remaining after LPG shrinkage. It is important to point out that in India LPG extraction from natural gas commenced only in 1981/82.

In the power sector, it is assumed (for sake of consistency) that the power generation conversion efficiency of hydro and nuclear power plants is the same as that for coal based steam thermal power plants. This is a very standard practice for constructing energy balance tables. The auxiliary consumption of various types of power generating plants are assumed to be as follows: (i) 10% of gross generation for coal based steam thermal and nuclear power stations; (ii) similarly, 10% for diesel power plants; (iii) 2% for gas turbine units; and (iv) 0.5% for hydropower plants.

These norms are average figures observed empirically from past data. The use of petroleum products for power generation is as given in official statistics of the Department of Petroleum and Natural Gas. These data are estimates of consumption in utilities only. Diesel consumed by industries for captive generation is included in consumption by industries. No better estimates are available.

Not all soft-coke and kerosene are consumed by the residential sector. They are also consumed for other energy uses. However, such disaggregate data is not available. The National Council of Applied Economic Research (NCAER), India, had conducted a detailed survey in 1978/79, the results of which indicated that about 37% of total soft coke and a little over 16% of kerosene is consumed by commercial establishments. We have used the same norms in the energy balances.

As for stock changes, data are available only for the coal sector. Similar data are not available for crude oil and refined products. Therefore, estimates for changes in stocks of these items represent indigenous production plus imports minus exports and sales/consumption. The estimates for stock changes that have been so derived give no indication of the actual stock levels.

Total commercial energy supplies (net of changes in stocks) in India increased from about 68.5 mtoe in 1972/73 to 163 mtoe in 1988/89 at the rate of over 5.2% per annum. During the same time period, indigenous production of commercial energy increased from about 53 mtoe to over 144 mtoe, at the rate of over 6% per annum. The share of indigenous production of commercial energy (in the total commercial energy availability mix) therefore increased from 77% in 1972/73 to a little over 88% in 1988/89.

Much of this increased production was in the form of fossil fuels: coal, oil and natural gas. Coal production increased from an estimated 41 mtoe in 1972/73 to over 95 mtoe in 1988/89, as opencast mining increased and new mining techniques were introduced. Larger and more powerful equipment (shovels, draglines, dumpers etc.) are now being deployed to permit opencast mining up to a depth of as much as 500 metres. However, with the increase in opencast mining, the average quality of mined coal has deteriorated.

The increase in oil and gas production was due largely to the accelerated development of the Bombay High Offshore basin. Crude oil production more than quadrupled during the seventeen year time period, from about 7.3 MMT in 1972/73 to a little over 32 MMT in 1988/89. Gross natural gas production increased phenomenally from 1565 million cubic metres (mcm) or 1.34 mtoe in 1972/73 to 13217 mcm (11.324 mtoe) in 1988/89. A significant part of the natural gas produced however, continues to be flared because of several reasons. Delays in commissioning downstream gas utilization facilities is only one factor. There is apparently little flexibility in reducing the production of associated gases, which will be possible only if oil production is also limited -- but which may lead to a higher oil import bill. It is possible to limit the production of gas only from fields which have non-associated gas reserves (e.g. South Bassein)· the production rate from such fields may be adjusted to the extent gas can be utilized purposefully downstream. Gas flaring has increased from 653 mcm in 1972/73 to 3967 mcm in 1988/89.

Primary nuclear generation increased from 0.095 mtoe in 1972/73 to 0.49 mtoe in 1988/89. Similarly, primary hydroelectric energy generation also increased from 2.3 mtoe to over 4.8 mtoe during the same time period.

India continues to be a net energy importer, net crude oil and petroleum product imports in 1988/89 being 24.2 mtoe. In 1980/81, the net imports were over 24 mtoe while in 1972/73 they were about 15 mtoe. Imports of superior grade coal were about 0.735 mtoe in 1980/81, and gradually increased to 1.456 mtoe in 1988/89. As a percentage of foreign exchange earnings through commodity exports, India's net oil imports were as low as 10% in 1972/73. They reduced from about 78% in 1980/81 to about 19% in 1988/89. This is due largely to: (i) a rapid increase in indigenous crude production, at least until 1984/85, when nearly 29 MMT were produced; and (ii) generally soft oil prices in the international market, particularly after 1986. However, the outlook for a further rapid increase in indigenous crude production, as witnessed during 1980/81 to 1984/85 period, is not very encouraging -- in fact, crude oil production has more-or-less stabilized at about 30 MMT per annum since 1984/85.

Net availability of commercial energy for final consumption increased from about 54 mtoe in 1972/73 to over 110 mtoe in 1988/89, at the rate of 4.3% per annum. Commercial energy consumption increased at a higher rate of 5.4% per annum in 1980s. Energy lost in conversion processes (power generation, oil refining, soft-coke production etc.) increased from about 14.3 mtoe to nearly 53 mtoe during the seventeen year period.

The final consumption pattern for 1972/73 through 1988/89, shown in Table 1.1 through I.17 is based on official estimates of sectoral energy consumption, as published in various official statistical statements of the Government of India. The total energy consumed in 1978/79 was 68.2 mtoe as compared to 68.8 in 1977/78. This was due to a drop in the consumption of coal in 1978/79. The decline in energy consumed in 1980/81, however, may be attributed to our assumption of a lower calorific value of 5000 kCal per kilogram of coal.

Although there may be significant shortcomings in the consumption pattern (such as split between HSD/LDO consumption between transport and agriculture sectors, split of total naphtha consumed in industry for energy purposes and as feedstock), the data presented do highlight some important aspects. For instance, including the use of coal, naphtha and natural gas as feedstock, it is evident that the industrial sector is the major commercial energy consuming sector. During 1972/73, it accounted for about 30 mtoe or 54.9% of total final consumption. The corresponding figures for 1988/89 are 56.2 mtoe and 50.6% respectively.

It is shown that the transport sector is major oil consuming sector. Transport sector accounted for about 36% of total consumption of petroleum products in 1972/73, and its share rose to over 47% in 1988/89. The agricultural, residential and other sectors do not appear to be major commercial energy consumers. It is important to realize however, that if the role of traditional fuels and draught animal power are also considered, sectoral shares of (total) final energy consumption would be considerably different.

Table I.1 : Commercial Energy

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	41.638	7.321	1.340	2.295	0.095	-	-	-
- Imports	-	12.084	-	-	-	-	-	0.076
- Exports	0.248	-	-	-	-	-	-	0.001
- Stock Changes	(-)0.782	0.077	-	-	-	-	(-)0.01	0.051
B. AVAILABILITY	42.172	19.328	1.340	2.295	0.095	-	0.01	0.024
C. CONVERSION	(-)14.38	(-)19.329	(-)0.97	-	-	-	0.265	1.397
- Soft Coke	1.850	-	-	-	-	1.427	-	-
- Petroleum Refining	-	19.328	-	-	-	-	0.265	1.397
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	12.53	-	0.290	2.295	0.095	-	-	-
- Conversion Losses	(-)8.353	-	(-)0.206	(-)1.53	(-)0.063	-	-	-
- Aux Cons. in Power Station	(-)0.418	-	(-)0.001	(-)0.003	(-)0.003	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	0.680	-	-	-	-	-
D. NET AVAILABILITY	27.792	-	0.370	-	-	1.427	0.275	1.421
E. CONSUMPTION	27.792	-	0.370	-	-	1.427	0.275	1.421
- Agriculture	-	-	0.017	-	-	-	-	-
- Industry	21.794‡	-	0.191	-	-	-	0.044	-
- Transport	6.008	-	-	-	-	-	-	-
- Residential	-	-	-	-	-	0.892	0.219	-
- Other Energy Uses	-	-	-	-	-	0.535	0.012	-
- Non Energy Uses	-	-	0.172	-	-	-	-	1.421

‡ Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

Balance for India (1972/73)
(mtoe)

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	2.39	52.689
-	-	0.833	0.150	0.406	1.777	0.160	3.402	-	-	15.486
0.005	0.002	0.053	0.037	0.012	0.002	0.011	0.123	-	-	0.371
0.002	0.018	0.022	0.055	0.032	(-)0.092	(-)0.052	0.026	-	-	(-)0.679
(-)0.007	(-)0.02	0.758	0.058	0.362	1.967	0.201	3.253	-	-	68.483
-	0.872	2.891	4.751	0.91	2.165	2.142	17.102	10.237	12.968	(-)14.396
-	-	-	-	-	-	-	-	-	-	(-)0.423
1.709	0.872	2.991	4.872	1.062	3.693	2.142	18.903	-	-	(-)0.425
-	-	-	0.121	0.152	1.528	-	1.901	14.621	17.011	17.011
-	-	-	(-)0.080	(-)0.101	(-)1.018	-	(-)1.199	(-)9.758	(-)11.351	(-)11.351
-	-	-	(-)0.004	(-)0.005	(-)0.051	-	(-)0.06	(-)0.479	(-)0.495	(-)0.485
-	-	-	-	-	-	-	-	-	(-)1.032	(-)1.032
-	-	-	-	-	-	-	-	-	-	(-)0.68
1.702	0.852	3.649	4.809	1.272	4.032	2.343	20.355	4.3848	4.143	54.087
1.702	0.852	3.649	4.809	1.272	4.032	2.343	20.355	-	4.143	54.087
-	-	-	0.034	0.046	0.184	-	0.264	-	0.499	0.780
-	-	-	0.351	1.179	3.456	-	5.030	-	2.722	29.717
1.702	0.852	-	4.424	0.047	0.392	-	7.417	-	0.154	13.579
-	-	3.058	-	-	-	-	3.277	-	0.364	4.533
-	-	0.591	-	-	-	-	0.603	-	0.404	1.542
-	-	-	-	-	-	2.343	3.764	-	-	3.936

Table I.2 : Commercial Energy

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	42.150	7.189	1.467	2.445	0.202	-	-	-
- Imports	-	13.873	-	-	-	-	-	0.162
- Exports	0.334	0.018	-	-	-	-	-	0.036
- Stock Changes	(-)0.070	0.086	-	-	-	-	(-)0.004	0.063
B. AVAILABILITY	41.886	20.958	1.467	2.445	0.202	-	0.004	0.063
C. CONVERSION	(-)14.983	(-)20.958	(-)1.092	-	-	-	0.298	1.546
- Soft Coke	2.347	-	-	-	-	1.860	-	-
- Petroleum Refining	-	20.958	-	-	-	-	0.298	1.546
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	12.636	-	0.277	2.445	0.202	-	-	-
- Conversion Losses	(-)8.424	-	(-)0.196	(-)1.630	(-)0.134	-	-	-
- Aux Cons. in Power Station	(-)0.421	-	(-)0.001	(-)0.004	(-)0.006	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	0.815	-	-	-	-	-
D. NET AVAILABILITY	26.903	-	0.375	-	-	1.860	0.302	1.609
E. CONSUMPTION	26.903	-	0.375	-	-	1.860	0.302	1.609
- Agriculture	-	-	0.018	-	-	-	-	-
- Industry	21.445*	-	0.204	-	-	-	0.047	-
- Transport	5.458	-	-	-	-	-	-	-
- Residential	-	-	-	-	-	1.163	0.242	-
- Other Energy Uses	-	-	-	-	-	0.697	0.013	-
- Non Energy Uses	-	-	0.153	-	-	-	-	1.609

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* Includes coking coal use and coal used as feed stock

$ T/D losses not accounted for.

Balance for India (1973/74)
(mtoe)

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	2.647	53.453
-	-	0.916	0.295	0.261	1.912	0.127	3.573	-	-	17.446
0.008	0.003	0.054	0.056	0.01	-	0.005	0.172	-	-	0.524
0.035	0.066	0.012	0.008	0.028	(-)0.026	(-)0.005	0.177	-	-	0.193
(-)0.043	(-)0.069	0.850	0.231	0.223	1.838	0.127	3.224	-	-	70.182
1.667	0.921	2.598	5.289	0.964	2.307	2.093	17.693	10.373	13.237	(-)15.896
-	-	-	-	-	-	-	-	-	-	(-)0.487
1.667	0.921	2.598	5.411	1.118	3.949	2.093	19.601	-	-	(-)1.357
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.122	0.154	1.642	-	1.918	14.831	17.478	17.478
-	-	-	(-)0.081	(-)0.102	(-)1.094	-	(-)1.277	(-)9.897	(-)11.661	(-)11.561
-	-	-	(-)0.004	(-)0.005	(-)0.054	-	(-)0.063	(-)0.476	(-)0.486	(-)0.486
-	-	-	-	-	-	-	-	-	(-)1.090	(-)1.090
-	-	-	-	-	-	-	-	-	-	(-)0.815
1.624	0.952	3.448	5.52	1.187	4.145	2.220	20.907	4.4588	4.241	54.296
1.624	0.852	3.448	5.52	1.187	4.145	2.220	20.907	-	4.241	54.286
-	-	-	0.047	0.042	0.206	-	0.295	-	0.532	0.845
-	-	-	0.466	1.099	3.558	-	5.170	-	2.742	29.561
1.624	0.852	-	5.007	0.046	0.381	-	7.910	-	0.129	13.497
-	-	2.890	-	-	-	-	3.132	-	0.392	4.687
-	-	0.558	-	-	-	-	0.571	-	0.446	1.714
-	-	-	-	-	-	2.220	3.829	-	-	3.982

Table I.3 : Commercial Energy

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	47.672	7.684	1.748	2.352	0.196	-	-	-
- Imports	-	14.016	-	-	-	-	-	0.045
- Exports	0.291	-	-	-	-	-	-	0.123
- Stock Changes	1.225	0.606	-	-	-	-	(-)0.009	(-)0.026
B. AVAILABILITY	46.156	21.094	1.748	2.352	0.186	-	0.008	(-)0.052
C. CONVERSION	(-)15.811	(-)21.094	(-)1.237	-	-	-	0.322	1.849
- Soft Coke	2.215	-	-	-	-	1.784	-	-
- Petroleum Refining	-	21.094	-	-	-	-	0.322	1.849
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	13.596	-	0.303	2.352	0.196	-	-	-
- Conversion Losses	(-)9.064	-	(-)0.215	(-)1.568	(-)0.124	-	-	-
- Aux Cons. in Power Station	(-)0.453	-	(-)0.001	(-)0.003	(-)0.006	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	0.934	-	-	-	-	-
D. NET AVAILABILITY	30.345	-	0.511	-	-	1.784	0.33	1.797
E. CONSUMPTION	30.345	-	0.511	-	-	1.734	0.33	1.797
- Agriculture	-	-	0.025	-	-	-	-	-
- Industry	25.977$	-	0.209	-	-	-	0.05	-
- Transport	4.368	-	-	-	-	-	-	-
- Residential	-	-	0.005	-	-	1.116	0.263	-
- Other Energy Uses	-	-	-	-	-	0.668	0.017	-
- Non Energy Uses	-	-	0.272	-	-	-	-	1.797

$ Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

Balance for India (1974/75)
(mtoe)

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	2.538	59.642
-	-	0.810	0.255	0.059	1.365	0.134	2.668	-	-	16.684
0.005	-	0.033	0.011	0.007	-	0.022	0.201	-	-	0.492
(-)0.015	0.072	(-)0.130	0.127	0.036	0.029	0.024	0.109	-	-	1.940
0.01	(-)0.072	0.907	0.117	0.016	1.336	0.088	2.358	-	-	73.894
1.334	0.948	2.115	6.331	0.981	2.573	1.732	18.185	11.086	13.931	(-)16.269
-	-	-	-	-	-	-	-	-	-	(-)0.431
1.334	0.948	2.115	6.422	1.096	4.303	1.732	20.121	-	-	(-)0.973
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.091	0.115	1.730	-	1.936	15.835	18.373	18.373
-	-	-	(-)0.06	(-)0.076	(-)1.153	-	(-)1.289	(-)10.568	(-)12.26	(-)12.260
-	-	-	(-)0.003	(-)0.004	(-)0.057	-	(-)0.064	(-)0.518	(-)0.527	(-)0.527
-	-	-	-	-	-	-	-	-	(-)1.144	(-)1.144
-	-	-	-	-	-	-	-	-	-	(-)0.934
1.344	0.876	3.022	5.448	0.997	3.909	1.820	20.543	-	4.442	57.625
1.344	0.876	3.022	6.448	0.997	3.909	1.820	20.543	4.7498	4.442	57.525
-	-	-	0.045	0.035	0.158	-	0.238	-	0.655	0.918
-	-	-	0.448	0.913	3.443	-	4.954	-	2.759	33.799
1.344	0.876	-	5.955	0.049	0.308	-	8.532	-	0.129	13.029
-	-	2.533	-	-	-	-	2.796	-	0.437	4.354
-	-	0.489	-	-	-	-	0.506	-	0.462	1.536
-	-	-	-	-	-	1.820	3.617	-	-	3.889

Table I.4 : Commercial Energy

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	53.749	8.448	2.029	2.811	0.221	-	-	-
- Imports	-	13.624	-	-	-	-	-	0.008
- Exports	0.237	-	-	-	-	-	-	0.097
- Stock Changes	3.786	(-)0.211	-	-	-	-	0.016	(-)0.073
B. AVAILABILITY	49.726	22.283	2.029	2.811	0.221	-	(-)0.016	(-)0.016
C. CONVERSION	(-)17.28	(-)22.283	(-)1.38	-	-	-	0.374	2.053
- Soft Coke	1.900	-	-	-	-	1.746	-	-
- Petroleum Refining	-	22.283	-	-	-	-	0.374	2.053
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	15.38	-	0.314	2.811	0.221	-	-	-
- Conversion Losses	(-)10.253	-	(-)0.176	(-)1.874	(-)0.147	-	-	-
- Aux Cons. in Power Station	(-)0.512	-	(-)0.002	(-)0.005	(-)0.007	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	1.066	-	-	-	-	-
D. NET AVAILABILITY	32.446	-	0.649	-	-	-	-	-
E. CONSUMPTION	32.446	-	0.649	-	-	1.746	0.358	2.037
- Agriculture	-	-	0.029	-	-	-	-	-
- Industry	26.839*	-	0.211	-	-	-	0.052	-
- Transport	5.607	-	-	-	-	-	-	-
- Residential	-	-	0.011	-	-	1.092	0.286	-
- Other Energy Uses	-	-	-	-	-	0.654	0.020	-
- Non Energy Uses	-	-	0.399	-	-	-	-	2.037

* Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

Balance for India (1975/76)
(mtoe)

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	3.032	67.258
-	-	0.739	0.550	-	0.790	0.099	2.186	-	-	15.81
0.001	-	0.01	0.005	0.006	-	0.054	0.173	-	-	0.41
0.003	0.03	0.044	0.225	0.065	0.115	(-)0.061	0.364	-	-	3.939
(-)0.004	(-)0.03	0.685	0.32	(-)0.071	0.675	0.106	1.649	-	-	78.719
1.364	0.985	2.548	6.438	0.894	3.277	1.569	19.502	12.258	14.291	(-)17.642
-	-	-	-	-	-	-	-	-	-	(-)0.154
1.364	0.985	2.548	6.505	0.979	5.006	1.569	21.383	-	-	(-)0.9
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.067	0.085	1.729	-	1.881	17.575	20.607	20.607
-	-	-	(-)0.04	(-)0.056	(-)1.153	-	(-)1.253	(-)11.682	(-)13.703	(-)13.703
-	-	-	(-)0.002	(-)0.003	(-)0.057	-	(-)0.062	(-)0.576	(-)0.588	(-)0.588
-	-	-	-	-	-	-	-	-	(-)1.231	(-)1.231
-	-	-	-	-	-	-	-	-	-	(-)1.066
1.360	0.955	3.233	6.758	0.823	3.952	1.675	21.151	5.3178	5.085	61.077
1.360	0.955	3.233	6.758	0.823	3.952	1.675	21.151	-	5.085	61.077
-	-	-	0.036	0.028	0.142	-	0.206	-	0.736	0.970
-	-	-	0.367	0.726	3.448	-	4.593	-	3.171	34.814
1.360	0.955	-	6.355	0.069	0.362	-	9.101	-	0.157	14.865
-	-	2.710	-	-	-	-	2.996	-	0.491	4.590
-	-	0.523	-	-	-	-	0.543	-	0.53	1.727
-	-	-	-	-	-	1.675	3.712	-	-	4.111

Table 1.5 : Commercial Energy

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	54.482	8.898	2.080	2.940	0.274	-	-	-
- Imports	-	14.048	-	-	-	-	-	0.205
- Exports	0.345	-	-	-	-	-	-	-
- Stock Changes	0.135	(-)0.049	-	-	-	-	(-)0.001	(-)0.006
B. AVAILABILITY	54.002	22.995	2.080	2.940	0.274	-	0.001	0.211
C. CONVERSION	(-)19.907	(-)22.995	(-)1.91	-	-	2.071	0.410	2.135
- Soft Coke	2.100	-	-	-	-	2.071	-	-
- Petroleum Refining	-	22.995	-	-	-	-	0.410	2.135
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	17.807	-	0.294	2.94	0.274	-	-	-
- Conversion Losses	(-)11.871	-	(-)0.208	1.96	0.182	-	-	-
- Aux Cons. in Power Station	(-)0.593	-	(-)0.001	(-)0.004	(-)0.009	-	-	-
- T/D Losses	-	-	-	-	-	-		-
- Nat Gas Flaring etc	-	-	(-)0.997	-	-	-	-	-
D. NET AVAILABILITY	34.095	-	0.889	-	-	2.071	0.411	2.346
E. CONSUMPTION	34.095	-	0.889	-	-	2.071	0.411	2.346
- Agriculture	-	-	0.033	-	-	-	-	-
- Industry	28.93‡	-	0.254	-	-	-	0.059	-
- Transport	5.165	-	-	-	-	-	-	-
- Residential	-	-	0.013	-	-	1.295	0.334	-
- Other Energy Uses	-	-	-	-	-	0.776	0.018	-
- Non Energy Uses	-	-	0.599	-	-	-	-	2.346

‡ Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

Balance for India (1976/77)
(mtoe)

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	3.214	68.674
-	-	0.731	0.662	-	0.999	0.075	2.672	-	-	16.72
-	-	-	-	-	-	0.071	0.071	-	-	0.416
0.025	0.027	(-)0.069	(-)0.07	0.031	0.025	(-)0.104	(-)0.142	-	-	(-)0.056
(-)0.025	(-)0.027	0.8	0.732	(-)0.031	0.974	0.108	2.743	-	-	85.034
1.433	1.045	2.671	6.535	1.014	3.125	1.888	20.256	13.881	16.036	(-)19.357
-	-	-	-	-	-	-	-	-	-	(-)0.029
1.433	1.045	2.671	6.623	1.125	4.657	1.888	21.987	-	-	(-)1.008
-	-	-	0.088	0.111	1.532	-	1.731	19.832	23.046	23.046
-	-	-	(-)0.058	(-)0.074	(-)1.021	-	(-)1.153	(-)13.232	(-)15.374	(-)15.374
-	-	-	(-)0.003	(-)0.001	(-)0.051	-	(-)0.055	(-)0.649	(-)0.662	(-)0.662
-	-	-	-	-	-	-	-	-	(-)1.387	(-)1.387
-	-	-	-	-	-	-	-	-	-	(-)0.897
1.408	1.018	3.471	7.267	0.983	4.099	1.996	22.999	5.9518	5.622	65.676
1.408	1.018	3.471	7.267	0.983	4.099	1.996	22.999	-	5.622	65.676
-	-	-	0.049	0.033	0.14	-	0.222	-	0.812	1.067
-	-	-	0.488	0.874	3.583	-	5.004	-	3.512	37.7
1.408	1.018	-	6.730	0.076	0.376	-	9.608	-	0.182	14.955
-	-	2.909	-	-	-	-	3.243	-	0.534	5.085
-	-	0.562	-	-	-	-	0.58	-	0.582	1.938
-	-	-	-	-	-	1.996	4.342	-	-	4.931

Table I.7 : Commercial Energy

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	54.989	11.633	2.409	3.98	0.233	-	-	-
- Imports	0.118	14.657	-	-	-	-	-	0.323
- Exports	0.145	-	-	-	-	-	-	0.038
- Stock Changes	0.938	0.316	-	-	-	-	(-)0.006	0.013
B. AVAILABILITY	54.934	25.974	2.409	3.98	0.233	-	0.006	0.272
C. CONVERSION	(-)21.248	(-)25.974	(-)1.423	-	-	1.276	0.455	2.431
- Soft Coke	1.442	-	-	-	-	1.276	-	-
- Petroleum Refining	-	25.974	-	-	-	-	0.455	2.431
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	19.906	-	0.480	3.98	0.233	-	-	-
- Conversion Losses	(-)13.204	-	(-)0.340	(-)2.653	(-)0.155	-	-	-
- Aux Cons. in Power Station	(-)0.680	-	(-)0.002	(-)0.006	(-)0.007	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc	-	-	0.943	-	-	-	-	-
D. NET AVAILABILITY	32.776	-	0.986	-	-	1.276	0.461	2.703
E. CONSUMPTION	32.776	-	0.986	-	-	1.276	0.461	2.703
- Agriculture	-	-	0.037	-	-	-	-	-
- Industry	28.02‡	-	0.301	-	-	-	0.067	-
- Transport	4.756	-	-	-	-	-	-	-
- Residential	-	-	0.011	-	-	0.798	0.373	-
- Other Energy Uses	-	-	-	-	-	0.478	0.021	-
- Non Energy Uses	-	-	0.637	-	-	-	-	2.703

‡ Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

Balance for India (1978/79)
(mtoe)

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.213	73.244
-	-	1.514	1.159	0.024	0.898	0.069	3.987	-	-	18.762
-	-	-	-	-	-	0.007	0.045	-	-	0.190
0.018	0.024	0.012	(-)0.174	0.035	(-)0.110	(-)0.025	(-)0.213	-	-	1.041
(-)0.018	(-)0.024	1.502	1.333	(-)0.011	1.008	0.087	4.155	-	-	90.775
1.621	1.253	2.627	7.556	1.205	3.401	2.016	22.565	15.614	20.069	(-)22.493
-	-	-	-	-	-	-	-	-	-	(-)0.166
1.621	1.253	2.627	7.607	1.269	5.559	2.016	24.838	-	-	(-)1.136
-	-	-	0.051	0.064	2.159	-	2.273	22.559	26.772	26.772
-	-	-	(-)0.034	(-)0.042	(-)1.438	-	(-)1.514	(-)14.378	(-)17.866	(-)17.866
-	-	-	(-)0.001	(-)0.002	(-)0.071	-	(-)0.074	(-)0.736	(-)0.749	(-)0.749
-	-	-	-	-	-	-	-	-	(-)1.633	(-)1.633
-	-	-	-	-	-	-	-	-	-	(-)0.943
1.603	1.229	4.129	8.889	1.194	4.409	2.103	26.72	6.9458	6.524	68.282
1.603	1.229	4.129	8.889	1.194	4.409	2.103	26.72		6.524	69.292
-	-	-	0.084	0.041	0.131	-	0.256	-	1.015	1.308
-	-	-	0.842	1.070	3.970	-	5.949	-	4.029	38.299
1.603	1.229	-	7.963	0.083	0.308	-	11.186	-	0.185	16.127
-	-	3.461	-	-	-	-	3.834	-	0.639	5.282
-	-	0.668	-	-	-	-	0.689	-	0.656	1.823
-	-	-	-	-	-	2.103	4.806	-	-	5.443

Table I.6 : Commercial Energy

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	54.417	10.763	2.432	3.208	0.119	-	-	-
- Imports	-	14.507	-	-	-	-	-	0.279
- Exports	0.355	-	-	-	-	-	-	-
- Stock Changes	(-)1.897	0.372	-	-	-	-	(-)0.009	0.097
B. AVAILABILITY	55.959	24.898	2.432	-	-	-	0.009	0.182
C. CONVERSION	(-)20.096	(-)24.898	(-)1.497	-	-	1.867	0.432	2.279
- Soft Coke	1.906	-	-	-	-	1.857	-	-
- Petroleum Refining	-	24.898	-	-	-	-	0.432	2.279
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	18.19	-	0.319	3.208	0.119	-	-	-
- Conversion Losses	(-)12.126	-	(-)0.226	(-)2.138	(-)0.079	-	-	-
- Aux Cons. in Power Station	(-)0.606	-	(-)0.002	(-)0.005	(-)0.004	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc	-	-	1.178	-	-	-	-	-
D. NET AVAILABILITY	35.863	-	0.935	-	-	1.867	0.441	2.461
E. CONSUMPTION	35.863	-	0.935	-	-	1.967	0.441	2.451
- Agriculture	-	-	0.033	-	-	-	-	-
- Industry	30.793‡	-	0.289	-	-	-	0.063	-
- Transport	5.07	-	-	-	-	-	-	-
- Residential	-	-	0.011	-	-	1.169	0.357	-
- Other Energy Uses	-	-	-	-	-	0.699	0.021	-
- Non Energy Uses	-	-	0.603	-	-	-	-	2.451

‡ Includes coking coal use and coal used as feed stock

§ T/D losses not accounted for.

Balance for India (1977/78)
(mtoe)

O N D A R Y   E N E R G Y

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	3.327	70.939
-	-	1.338	0.802	-	0.504	0.05	2.973	-	-	17.48
-	-	-	-	-	-	0.047	0.047	-	-	0.402
0.034	0.039	0.101	0.174	0.062	0.005	0.031	0.534	-	-	(-)0.991
(-)0.034	(-)0.039	1.237	0.628	(-)0.062	0.499	(-)0.028	2.392	-	-	89.008
1.522	1.147	2.560	7.308	1.178	3.446	2.05	21.922	14.333	16.559	(-)20.183
-	-	-	-	-	-	-	-	-	-	(-)0.039
1.522	1.147	2.560	7.378	1.266	5.252	2.050	23.986	-	-	(-)1.012
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.070	0.099	1.806	-	1.954	20.473	23.8	23.8
-	-	-	(-)0.046	(-)0.058	(-)1.204	-	(-)1.308	(-)13.66	(-)15.977	(-)15.977
-	-	-	(-)0.002	(-)0.003	(-)0.06	-	(-)0.065	(-)0.673	(-)0.692	(-)0.692
-	-	-	-	-	-	-	-	-	(-)1.395	(-)1.395
-	-	-	-	-	-	-	-	-	-	(-)1.179
1.488	1.108	3.797	7.936	1.116	3.945	2.022	24.314	6.148	5.846	69.925
1.488	1.108	3.797	7.936	1.116	3.945	2.022	24.314	-	5.846	68.925
-	-	-	0.063	0.038	0.137	-	0.238	-	0.853	1.124
-	-	-	0.643	1.003	3.437	-	5.146	-	3.599	39.826
1.488	1.108	-	7.230	0.075	0.371	-	10.272	-	0.194	15.536
-	-	3.182	-	-	-	-	3.539	-	0.576	5.294
-	-	0.615	-	-	-	-	0.636	-	0.624	1.959
-	-	-	-	-	-	2.022	4.483	-	-	5.086

Table I.8 : Commercial Energy

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	56.078	11.766	2.370	3.838	0.242	-	-	-
- Imports	0.506	16.121	-	-	-	-	-	0.140
- Exports	0.048	-	-	-	-	-	-	0.094
- Stock Changes	(-)0.404	0.413	-	-	-	-	(-)0.005	0.048
B. AVAILABILITY	56.94	27.474	2.370	3.838	0.242	-	0.005	(-)0.002
C. CONVERSION	(-)22.021	(-)27.474	(-)1.374	-	-	1.535	0.458	2.596
•								
- Soft Coke	1.571	-	-	-	-	1.535	-	-
- Petroleum Refining	-	27.474	-	-	-	-	0.458	2.596
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	20.45	-	0.440	3.838	0.242	-	-	-
- Conversion Losses	(-)13.633	-	(-)0.312	(-)2.558	(-)0.161	-	-	-
- Aux Cons. in Power Station	(-)0.581	-	(-)0.002	(-)0.006	(-)0.008	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc	-	-	0.934	-	-	-	-	-
D. NET AVAILABILITY	34.919	-	0.996	-	-	1.535	0.463	2.594
E. CONSUMPTION	34.919	-	0.996	-	-	1.535	0.463	2.594
- Agriculture	-	-	0.034	-	-	-	-	-
- Industry	30.465$	-	0.283	-	-	-	0.063	-
- Transport	4.454	-	-	-	-	-	-	-
- Residential	-	-	0.011	-	-	0.960	0.375	-
- Other Energy Uses	-	-	-	-	-	0.575	0.025	-
- Non Energy Uses	-	-	0.668	-	-	-	-	2.594

$ Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

Balance for India (1979/80)
(mtoe)

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.08	74.294
-	-	1.558	1.906	0.079	0.729	0.097	4.509	-	-	21.136
-	-	-	-	-	-	-	0.094	-	-	0.142
0.023	(-)0.043	0.165	0.016	0.042	0.01	(-)0.041	0.215	-	-	0.224
(-)0.023	0.043	1.393	1.89	0.037	0.719	0.138	4.2	-	4.992	95.064
1.617	1.175	2.653	8.196	1.2	4.153	2.171	24.219	16.189	20.611.	22.603
-	-	-	-	-	-	-	-	-	-	(-)0.036
1.617	1.175	2.653	8.254	1.273	6.255	2.171	26.452	-	-	(-)1.022
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.058	0.073	2.102	-	2.233	23.123	27.203	27.203
-	-	-	(-)0.038	(-)0.048	(-)1.401	-	(-)1.487	(-)15.432	(-)18.151	(-)18.151
-	-	-	(-)0.002	(-)0.002	(-)0.07	-	(-)0.074	(-)0.757	(-)0.771	(-)0.771
-	-	-	-	-	-	-	-	-	(-)1.689	(-)1.689
-	-	-	-	-	-	-	-	-	-	(-)0.934
1.594	1.218	4.046	10.086	1.237	4.827	2.309	28.419	6.9348	6.592	72.461
1.594	1.218	4.046	10.086	1.237	4.827	2.309	28.419		6.592	72.461
-	-	-	0.097	0.042	0.142	-	0.281	-	1.135	1.45
-	-	-	0.98	1.099	4.404	-	6.546	-	3.88	41.174
1.594	1.218	-	9.009	0.096	0.326	-	12.243	-	0.195	16.892
-	-	3.391	-	-	-	-	3.766	-	0.709	5.446
-	-	0.655	-	-	-	-	0.680	-	0.673	1.928
-	-	-	-	-	-	2.309	4.903	-	-	5.571

Table I.9 : Commercial Energy Balance for India (1980/81)
(mtoe)

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	55.89	10.507	2.020	3.928	0.253	-	-	-
- Imports	0.735	16.248	-	-	-	-	-	0.248
- Exports	0.054	-	-	-	-	-	-	0.038
- Stock Changes	2.944	0.919	-	-	-	-	(-)0.044	(-)0.016
B. AVAILABILITY	53.627	25.836	2.020	3.928	0.253	-	0.044	0.226
C. CONVERSION	(-) 23.198	(-)25.836	(-) 1.137	-	-	1.234	0.413	2.273
- Soft Coke	(-) 1.395	-	-	-	-	1.234	-	-
- Petroleum Refining	-	25.836					0.413	2.273
- LPG Extraction	-	-	-	-	-	-	-	-
- Power Generation	21.803	-	0.421	3.928	0.253	-	-	-
- Conversion Losses	(-) 14.535	-	(-)0.299	(-)2.619	(-)0.169	-	-	-
- Aux Cons. in Power Station	(-) 0.726	-	(-)0.002	(-)0.019	(-)0.008	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	0.716	-	-	-	-	-
D. NET AVAILABILITY	30.429	-	0.883	-	-	1.234	0.457	2.499
E. CONSUMPTION	30.429	-	0.883	-	-	1.234	0.457	2.499
- Agriculture	-	-	0.039	-	-	-	-	-
- Industry	25.798‡	-	0.290	-	-	-	0.064	-
- Transport	4.631	-	-	-	-	-	-	-
- Residential	-	-	0.012	-	-	0.771	0.37	-
- Other Energy Uses	-	-	-	-	-	0.463	0.023	-
- Non Energy Uses	-	-	0.542	-	-	-	-	2.499

‡ Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.181	72.598
-	0.034	2.157	3.331	0.070	1.316	0.324	7.48	-	-	24.463
-	-	-	-	-	-	-	0.038	-	-	0.092
(-)0.003	(-)0.098	0.242	0.253	0.056	(-)0.016	0.109	0.483	-	-	4.346
0.003	0.132	1.915	3.078	0.014	1.332	0.215	6.959	-	-	92.623
1.625	1.066	2.503	7.428	0.983	3.974	2.041	22.306	17.253	20.068	(-)23.859
-	-	-	-	-	-	-	-	-	-	(-)0.161
1.625	1.066	2.503	7.629	1.147	6.028	2.041	24.725			(-)1.111
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.201	0.164	2.054	-	2.419	24.643	28.824	28.824
-	-	-	(-)0.134	(-)0.109	(-)1.369	-	(-)1.612	(-)16.446	(-)19.234	19.234
-	-	-	(-)0.006	(-)0.00	(-)0.068	-	(-)0.079	(-)0.807	(-) 0.834	(-)0.834
-	-	-	-	-	-	-	-	-	(-)1.803	(-)1.803
-	-	-	-	-	-	-	-	-	-	(-)0.716
1.628	1.198	4.418	10.506	0.997	5.306	2.256	29.265	7.398	6.953	68.764
1.628	1.198	4.418	10.506	0.997	5.306	2.256	29.265	-	6.953	68.764
-	-	-	0.104	0.039	0.22	-	0.363	-	1.223	1.625
-	-	-	1.035	0.865	4.751	-	6.715	-	4.058	36.861
1.628	1.198	-	9.367	0.093	0.335	-	12.621	-	0.191	17.443
-	-	3.703	-	-	-	-	4.073	-	0.781	5.637
-	-	0.715	-	-	-	-	0.738	-	0.700	1.901
-	-	-	-	-	-	2.256	4.755	-	-	5.297

Table I.10: Commercial Energy Balance for India (1981/82)
(mtoe)

	PRIMARY ENERGY					S E C		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	61.24	16.194	3.299	4.184	0.255	-	-	-
- Imports	0.318	15.298	-	-	-	-	-	0.122
- Exports	0.078	0.838	-	-	-	-	-	0.059
- Stock Changes	2.157	0.508	-	-	-	-	(-)0.01	0.107
B. AVAILABILITY	59.323	30.146	3.299	4.184	0.255	1.242	0.01	(-)0.044
C. CONVERSION	(-)25.95	(-)30.146	(-)1.988	-	-	-	0.545	3.229
- Soft Coke	1.403	-	-	-	-	1.242	-	-
- Petroleum Refining	-	30.146	-	-	-	-	0.463	3.229
- LPG Extraction	-	-	0.082	-	-	-	0.082	-
- Power Generation	24.547	-	0.510	4.184	0.255	-	-	-
- Conversion Losses	(-)16.365	-	(-)0.362	(-)2.789	(-)0.170	-	-	-
- Aux Cons. in Power Station	(-)0.818	-	(-)0.003	(-)0.007	(-)0.008	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	(-)1.396	-	-	-	-	-
D. NET AVAILABILITY	33.373	-	1.311	-	-	1.242	0.555	3.185
E. CONSUMPTION	33.373	-	1.311	-	-	1.242	0.555	3.185
- Agriculture	-	-	0.039	-	-	-	-	-
- Industry	28.958*	-	0.411	-	-	-	0.057	-
- Transport	4.415	-	-	-	-	-	-	-
- Residential	-	-	0.012	-	-	0.776	0.479	-
- Other Energy Uses	-	-	-	-	-	0.466	0.019	-
- Non Energy Uses	-	-	0.849	-	-	-	-	3.185

* Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.439	85.172
-	0.117	2.057	1.902	0.086	0.519	0.233	5.036	-	-	20.652
-	-	-	-	-	-	-	0.059	-	-	0.975
0.017	(-)0.01	0.191	0.049	(-)0.04	0.247	0.186	0.773	-	-	3.438
(-)0.017	0.127	1.866	1.853	0.09	0.272	0.047	4.204	-	-	101.411
1.727	1.074	3.038	9.175	0.798	5.066	2.445	27.097	19.022	23.984	(-)26.567
-	-	-	-	-	-	-	-	-	-	(-)0.161
1.727	1.074	3.038	9.358	0.982	6.804	2.445	29.12	-	-	(-)1.026
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.183	0.184	1.738	-	2.105	27.162	31.601	31.601
-	-	-	(-)0.122	(-)0.123	(-)1.159	-	(-)1.404	(-)18.131	(-)21.090	(-)21.09
-	-	-	(-)0.006	(-)0.006	(-)0.058	-	(-)0.07	(-)0.891	(-)0.906	(-)0.906
-	-	-	-	-	-	-	-	-	(-)1.988	(-)1.988
-	-	-	-	-	-	-	-	-	-	(-)1.396
1.710	1.201	4.904	11.028	0.888	5.338	2.492	31.301	8.1400	7.617	74.844
1.710	1.201	4.904	11.028	0.888	5.338	2.492	31.301	-	7.617	74.844
-	-	-	0.101	0.031	0.170	-	0.302	-	1.283	1.624
-	-	-	1.089	0.757	4.856	-	6.759	-	4.479	40.607
1.710	1.201	-	9.838	0.1	0.312	-	13.161	-	0.211	17.787
-	-	4.110	-	-	-	-	4.589	-	0.881	6.258
-	-	0.794	-	-	-	-	0.813	-	0.763	2.042
-	-	-	-	-	-	2.492	5.677	-	-	6.526

Table I.11: Commercial Energy Balance for India (1982/83)
(mtoe)

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	73.818	21.063	4.229	4.083	0.171	-	-	-
- Imports	0.970	16.949	-	-	-	-	-	0.108
- Exports	0.073	4.552	-	-	-	-	-	0.103
- Stock Changes	10.907	0.304	-	-	-	-	(-)0.029	0.035
B. AVAILABILITY	63.808	33.156	4.229	4.083	0.171	-	0.029	(-)0.03
C. CONVERSION	(-)27.08	(-)33.156	(-)2.727	-	-	0.997	0.65	3.21
- Soft Coke	1.127	-	-		-	0.997	-	-
- Petroleum Refining	-	33.156	-	-	-	-	0.459	3.21
- LPG Extraction	-	-	0.191	-	-	-	0.191	-
- Power Generation	25.953	-	0.840	4.083	0.171	-	-	-
- Conversion Losses	(-)17.302	-	(-)0.596	(-)2.722	(-)0.114	-	-	-
- Aux Cons. in Power Station	(-)0.865	-	(-)0.005	(-)0.007	(-)0.006	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	1.696	-	-	-	-	-
D. NET AVAILABILITY	36.728	-	1.502	-	-	0.997	0.679	3.180
E. CONSUMPTION	36.728	-	1.502	-	-	0.997	0.679	3.180
- Agriculture	-	-	0.042	-	-	-	-	-
- Industry	32.434*	-	0.479	-	-	-	0.06	-
- Transport	4.294	-	-	-	-	-	-	-
- Residential	-	-	0.011	-	-	0.623	0.599	-
- Other Energy Uses	-	-	-	-	-	0.374	0.020	-
- Non Energy Uses	-	-	0.97	-	-	-	-	3.180

* Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.254	103.364
-	0.26	1.965	2.672	0.019	-	0.193	5.217	-	-	23.136
-	-	-	0.022	-	0.667	-	0.792	-	-	5.417
0.08	0.251	0.062	0.319	0.075	(-)0.014	0.07	0.849	-	-	12.06
(-)0.08	0.009	1.903	2.331	(-)0.056	(-)0.653	0.123	3.576	-	-	109.023
1.922	1.210	3.545	9.868	0.936	5.951	0.407	29.599	20.423	25.429	(-)28.552
-	-	-	-	-	-	-	-	-	-	(-)0.13
1.922	1.210	3.545	10.102	1.160	7.844	2.407	31.859	-	-	(-)1.297
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.234	0.224	1.993	-	2.451	29.244	33.498	33.498
-	-	-	(-)0.156	(-)0.149	(-)1.329	-	(-)1.634	(-)19.532	(-)22.368	(-)22.368
-	-	-	(-)0.008	(-)0.007	(-)0.006	-	(-)0.021	(-)0.891	(-)0.904	(-)0.904
-	-	-	-	-	-	-	-	-	(-)2.157	(-)2.157
-	-	-	-	-	-	-	-	-	-	(-)1.696
1.842	1.219	5.448	12.199	0.880	5.198	2.530	33.175	8.8218	8.069	80.471
1.842	1.219	5.448	12.199	0.880	5.198	2.530	33.175	-	8.069	80.471
-	-	-	0.118	0.028	0.169	-	0.315	-	1.504	1.861
-	-	-	1.314	0.75	4.717	-	6.841	-	4.471	44.225
1.842	1.219	-	10.767	0.102	0.312	-	14.242	-	0.222	18.758
-	-	4.566	-	-	-	-	5.165	-	1.021	6.82
-	-	0.882	-	-	-	-	0.902	-	0.851	2.127
-	-	-	-	-	-	2.530	5.710	-	-	6.68

Table I.12: Commercial Energy Balance for India (1983/84)
(mtoe)

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	67.764	26.020	5.108	4.217	0.299	-	-	-
- Imports	0.225	15.967	-	-	-	-	-	0.138
- Exports	0.039	5.522	-	-	-	-	-	0.968
- Stock Changes	0.651	1.202	-	-	-	-	(-)0.01	0.002
B. AVAILABILITY	67.299	35.263	5.108	4.217	0.299		0.01	(-)0.832
C. CONVERSION	(-)29.086	(-)35.263	(-)3.44	-	-	0.957	0.833	3.946
- Soft Coke	0.959	-	-	-	-	0.857	-	-
- Petroleum Refining	-	35.263	-	-	-	-	0.581	3.845
- LPG Extraction	-	-	0.252	-	-	-	0.252	-
- Power Generation	28.117	-	0.993	4.217	0.299	-	-	-
- Conversion Losses	(-)18.745	-	(-)0.705	(-)2.811	(-)0.199	-	-	-
- Aux Cons. in Power Station	(-)0.937	-	(-)0.006	(-)0.007	(-)0.01	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	2.195	-	-	-	-	-
D. NET AVAILABILITY	38.213	-	1.668	-	-	0.857	0.843	3.014
E. CONSUMPTION	38.213	-	1.668	-	-	0.857	0.943	3.014
- Agriculture	-	-	0.046	-	-	-	-	-
- Industry	34.017*	-	0.527	-	-	-	0.073	-
- Transport	4.196	-	-	-	-	-	-	-
- Residential	-	-	0.013	-	-	0.536	0.746	-
- Other Energy Uses	-	-	-	-	-	0.321	0.024	-
- Non Energy Uses	-	-	1.082	-	-	-	-	3.014

* Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

ONDARY ENERGY

MOSAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.516	103.408
-	0.180	2.121	1.869	0.043	-	0.146	4.497	-	-	20.689
-	-	-	0.059	-	0.043	0.071	1.141	-	-	6.702
0.049	0.275	(-)0.136	0.243	0.205	0.281	(-)0.311	0.598	-	-	2.451
(-)0.049	(-)0.095	2.257	1.567	(-)0.162	(-)0.324	0.386	2.758			114.944
2.072	1.381	3.515	11.324	1.07	5.577	1.93	31.548	22.19	27.555	(-)31.261
-	-	-	-	-	-	-	-	-	-	(-)0.112
2.072	1.381	3.515	11.474	1.297	7.768	1.93	33.864	-	-	(-)1.399
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.150	0.227	2.191	-	2.568	31.678	36.194	36.194
-	-	-	(-)0.100	(-)0.151	(-)1.461	-	(-)1.712	(-)21.162	(-)24.172	(-)24.172
-	-	-	(-)0.005	(-)0.007	(-)0.073	-	(-)0.085	(-)1.028	(-)1.045	(-)1.045
-	-	-	-	-	-	-	-	-	(-)2.338	(-)2.338
-	-	-	-	-	-	-	-	-	-	(-)2.195
2.023	1.286	5.772	12.891	0.908	5.253	2.316	34.306	9.4888	8.639	83.683
2.023	1.286	5.772	12.991	0.908	5.253	2.316	34.306	-	9.639	83.683
-	-	-	0.123	0.027	0.152	-	0.302	-	1.539	1.887
-	-	-	1.332	0.776	4.721	-	6.902	-	4.819	46.265
2.023	1.286	-	11.436	0.105	0.380	-	15.23	-	0.229	19.655
-	-	4.938	-	-	-	-	5.584	-	1.117	7.250
-	-	0.934	-	-	-	-	0.958	-	0.935	2.214
-	-	-	-	-	-	2.316	5.33	-	-	6.412

Table 1.13: Commercial Energy Balance for India (1984/85)
(mtoe)

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	72.269	28.99	6.204	4.54	0.344	-	-	-
- Imports	0.328	13.642	-	-	-	-	-	-
- Exports	0.059	6.478	-	-	-	-	-	0.658
- Stock Changes	3.156	0.598	-	-	-	-	(-)0.091	(-)0.287
B. AVAILABILITY	69.382	35.556	6.204	4.54	0.344	-	0.091	(-)0.371
C. CONVERSION	(-)32.498	(-)35.556	(-)4.159	-	-	0.848	0.986	3.73
- Soft Coke	0.958	-	-	-	-	0.848	-	-
- Petroleum Refining	-	35.556	-	-	-	-	0.673	3.730
- LPG Extraction	-	-	0.313	-	-	-	0.313	-
- Power Generation	31.54	-	1.190	4.54	0.344	-	-	-
- Conversion Losses	(-)21.027	-	(-)0.845	(-)3.027	(-)0.229	-	-	-
- Aux Cons. in Power Station	(-)1.051	-	(-)0.007	(-)0.007	(-)0.011	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	2.656	-	-	-	-	-
D. NET AVAILABILITY	36.884	-	2.045	-	-	0.848	1.077	3.359
E. CONSUMPTION	36.884	-	2.045	-	-	0.848	1.077	3.359
- Agriculture	-	-	0.051	-	-	-	0.085	-
- Industry	33.175*	-	0.639	-	-	-	-	-
- Transport	3.709	-	-	-	-	-	-	-
- Residential	-	-	0.015	-	-	0.53	0.965	-
- Other Energy Uses	-	-	-	-	-	0.319	0.027	-
- Non Energy Uses	-	-	1.340	-	-	-	-	3.359

* Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.884	112.347
-	0.136	2.728	2.663	-	0.172	0.581	6.28	-	-	20.25
-	-	-	0.073	-	0.167	0.077	0.975	-	-	7.512
0.064	0.094	0.016	(-)0.343	(-)0.121	0.06	0.429	(-)0.179	-	-	3.575
(-)0.064	0.042	2.712	2.933	0.121	(-)0.55	0.075	5.484	-	-	121.51
2.294	1.381	3.515	11.092	0.878	5.423	2.325	31.624	24.924	30.834	(-)34.997
-	-	-	-	-	-	-	-	-	-	(-)0.11
2.294	1.381	3.515	11.242	1.119	7.88	2.325	34.159	-	-	(-)1.397
-	-	-	-	-	-	-	-	-	-	-
-	-	-	0.150	0.241	2.457	-	2.948	35.578	40.462	40.462
-	-	-	(-)0.100	(-)0.161	(-)1.638	-	(-)1.899	(-)23.771	(-)27.027	(-)27.027
-	-	-	(-)0.005	(-)0.008	(-)0.082	-	(-)0.095	(-)1.153	(-)1.171	(-)1.171
-	-	-	-	-	-	-	-	-	(-)2.636	(-)2.636
-	-	-	-	-	-	-	-	-	-	(-)2.656
2.230	1.423	6.227	14.025	0.999	5.368	2.400	37.108	10.6548	9.628	86.513
2.230	1.423	6.227	14.025	0.999	5.368	2.400	37.108	-	9.628	86.513
-	-	-	0.133	0.03	0.149	-	0.311	-	1.769	2.131
-	-	-	1.639	0.87	4.868	-	7.462	-	5.319	46.595
2.23	1.423	-	12.253	0.099	0.352	-	16.357	-	0.243	20.309
-	-	5.219	-	-	-	-	6.184	-	1.309	8.038
-	-	1.008	-	-	-	-	1.035	-	0.988	2.341
-	-	-	-	-	-	2.400	5.759	-	-	7.099

Table I.14: Commercial Energy Balance for India (1985/86)
(mtoe)

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	75.637	30.168	6.969	4.299	0.421	-	-	-
- Imports	0.995	15.144	-	-	-	-	-	-
- Exports	0.103	0.528	-	-	-	-	-	1.930
- Stock Changes	0.284	1.874	-	-	-	-	(-)0.012	0.058
B. AVAILABILITY	76.245	42.910	6.969	4.299	0.421	-	0.012	(-)0.988
C. CONVERSION	(-)36.367	(-)42.910	(-)4.202	-	-	0.962	1.39	5.327
- Soft Coke	1.087	-	-	-	-	0.962	-	-
- Petroleum Refining	-	42.910	-	-	-	-	0.98	5.327
- LPG Extraction	-	-	0.410	-	-	-	0.410	-
- Power Generation	35.29	-	0.064	4.299	0.421	-	-	-
- Conversion Losses	(-)23.52	-	(-)0.755	(-)2.866	(-)0.231	-	-	-
- Aux Cons. in Power Station	(-)1.176	-	(-)0.006	(-)0.007	(-)0.014	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	2.728	-	-	-	-	-
D. NET AVAILABILITY	39.979	-	2.767	-	-	0.962	1.402	3.339
E. CONSUMPTION	39.878	-	2.767	-	-	0.962	1.402	3.339
- Agriculture	-	-	0.064	-	-	-	-	-
- Industry	36.109*	-	0.609	-	-	-	0.120	-
- Transport	3.769	-	-	-	-	-	-	-
- Residential	-	-	0.017	-	-	0.602	1.243	-
- Other Energy Uses	-	-	-	-	-	0.360	0.039	-
- Non Energy Uses	-	-	2.077	-	-	-	-	3.339

* Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.72	117.494
-	0.160	2.694	0.921	-	0.019	0.227	4.011	-	-	20.150
-	-	-	0.069	-	0.014	0.083	2.095	-	-	2.726
0.033	0.231	0.386	0.582	0.056	0.06	(-)0.059	1.335	-	-	3.493
(-)0.033	(-)0.071	2.298	0.271	(-)0.056	(-)0.055	0.203	0.581	-	-	131.425
2.467	1.618	4.211	14.97	0.954	5.540	2.350	39.827	27.363	33.408	(-)38.028
-	-	-	-	-	-	-	-	-	-	(-)0.125
2.467	1.618	4.211	15.136	1.213	7.936	2.350	41.143	-	-	(-)1.767
-	-	-	-	-	-	-	-	-	-	0.0
-	-	-	0.166	0.264	2.296	-	2.726	39.07	43.79	43.79
-	-	-	(-)0.110	(-)0.176	1.530	-	(-)1.816	(-)26.091	(-)29.238	(-)29.238
-	-	-	(-)0.005	(-)0.009	0.076	-	(-)0.09	(-)1.272	(-)1.293	(-)1.293
-	-	-	-	-	-	-	-	-	(-)0.377	(-)2.377
	-	-	-	-	-	-	-	-	-	(-)2.728
2.434	1.547	6.509	15.241	0.898	5.485	2.553	39.408	11.7078	10.382	93.397
2.434	1.547	6.509	15.241	0.898	5.485	2.553	39.408	-	10.382	93.397
-	-	-	0.154	0.031	0.163	-	0.348	-	1.977	2.389
-	-	-	1.756	0.779	5.033	-	7.687	-	5.654	50.059
2.434	1.547	-	13.331	0.089	0.289	-	17.690	-	0.26	21.719
-	-	5.455	-	-	-	-	6.598	-	1.456	9.773
-	-	1.054	-	-	-	-	1.093	-	1.035	2.488
-	-	-	-	-	-	2.553	5.892	-	-	7.969

ble 1.15: Commercial Energy Balance for India (1986/87)
toe)

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
· Production	81.22	30.48	9.443	4.539	0.424	-	-	-
· Imports	1.029	15.476	-	-	-	-	-	0.036
Exports,	0.078	-	-	-	-	-	-	2.386
· Stock Changes	0.382	0.257	-	-	-	-	(-)0.01	0.002
B. AVAILABILITY	81.789	45.699	8.443	4.538	0.424	-	0.01	(-)2.352
C. CONVERSION	(-)40.115	(-)45.669	(-)4.608	-	-	0.881	1.682	5.845
· Soft Coke	0.995	-	-	-	-	0.881	-	-
· Petroleum Refining	-	45.699'	-	-	-	-	1.124	5.845
· LPG Extraction	-	-	0.558	-	-	-	0.558	-
Power Generation	39.12	-	1.667	4.538	0.424	-	-	-
· Conversion Losses	(-)26.08	-	(-)1.183	(-)3.925	(-)0.282	-	-	-
· Aux Cons. in Power Station	(-)1.304	-	(-)0.009	(-)0.007	(-)0.014	-	-	-
· T/D Losses	-	-	-	-	-	-	-	-
· Nat Gas Flaring etc.	-	-	(-)2.383	-	-	-	-	-
D. NET AVAILABILITY	41.674	-	3.835	-	-	0.881	1.692	3.493
E. CONSUMPTION	41.674	-	3.835	-	-	0.881	1.692	3.493
· Agriculture	-	-	0.076	-	-	-	-	-
· Industry	38.49*	-	0.994	-	-	-	0.123	-
· Transport	3.184	-	-	-	-	-	-	-
· Residential	-	-	0.020	-	-	0.551	1.515	-
Other Energy Uses	-	-	-	-	-	0.33	0.054	-
· Non Energy Uses	-	-	2.745	-	-	-	-	3.493

* Includes coking coal use and coal used as feed stock

! T/D losses not accounted for.

O N D A R Y   E N E R G Y

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.962	125.105
-	0.115	1.985	0.775	-	-	0.245	3.157	-	-	19.662
-	-	-	-	0.083	0.097	0.088	2.654	-	-	2.732
0.011	0.062	0.174	0.198	(-)0.066	(-)0.132	(-)0.03	0.209	-	-	0.848
(-)0.011	0.053	1.811	0.578	(-)0.017	0.035	0.187	0.294	-	-	141.187
2.691	1.654	5.133	15.824	0.931	5.723	2.607	42.09	(-)30.406	(-)36.88	(-)40.927
-	-	-	-	-	-	-	-	-	-	(-)0.114
2.691	1.654	5.133	15.991	1.213	7.891	2.607	44.149	-	-	(-)1.55
-	-	-	-	-	-	-	-	-	-	0.0
-	-	-	0.167	0.282	2.168	-	2.617	43.404	48.366	48.366
-	-	-	(-)0.111	(-)0.188	(-)1.445	-	(-)1.744	(-)29.007	(-)32.314	(-)32.314
-	-	-	(-)0.005	(-)0.009	(-)0.072	-	(-)0.086	(-)1.399	(-)1.42	(-)1.42
-	-	-	-	-	-	-	-	-	(-)3.146	(-)3.146
-	-	-	-	-	-	-	-	-	-	(-)2.383
2.680	1.707	6.944	16.402	0.914	5.758	2.794	42.384	12.9988	11.486	100.260
2.680	1.707	6.944	16.402	0.914	5.758	2.794	42.384	-	11.486	100.260
-	-	-	0.160	0.031	0.158	-	0.349	-	2.382	2.807
-	-	-	1.744	0.794	5.243	-	7.904	-	6.035	53.423
2.680	1.707	-	14.498	0.089	0.357	-	19.331	-	0.274	22.799
-	-	5.82	-	-	-	-	7.335	-	1.526	9.532
-	-	1.124	-	-	-	-	1.178	-	1.169	2.677
-	-	-	-	-	-	2.794	6.287	-	-	9.032

Table I.16: Commercial Energy Balance for India (1987/88)
(mtoe)

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	88.509	30.357	9.825	3.994	0.424	-	-	-
- Imports	1.456	17.732	-	-	-	-	-	-
- Exports	0.083	-	-	-	-	-	-	2.814
- Stock Changes	3.681	0.335	-	-	-	-	(-)0.116	(-)0.008
B. AVAILABILITY	86.201	47.754	9.825	3.994	0.424	-	0.116	(-)2.806
C. CONVERSION	(-)47.762	(-)47.754	(-)5.838	-	-	0.730	1.789	5.872
- Soft Coke	0.825	-	-	-	-	0.730	-	-
- Petroleum Refining	-	47.754	-	-	-	-	1.159	5.872
- LPG Extraction	-	-	0.630	-	-	-	0.630	-
- Power Generation	46.937	-	2.210	3.994	0.424	-	-	-
- Conversion Losses	(-)31.291	-	(-)1.569	(-)2.663	(-)0.283	-	-	-
- Aux Cons. in Power Station	(-)1.564	-	(-)0.012	(-)0.020	(-)0.014	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	2.998	-	-	-	-	-
D. NET AVAILABILITY	38.439	-	3.987	-	-	0.730	1.905	3.066
E. CONSUMPTION	38.439	-	3.987	-	-	0.730	1.905	3.066
- Agriculture	-	-	0.080	-	-	-	-	-
- Industry	35.478‡	-	1.019	-	-	-	0.208	-
- Transport	2.961	-	-	-	-	-	-	-
- Residential	-	-	0.028	-	-	0.457	1.599	-
- Other Energy Uses	-	-	-	-	-	0.273	0.098	-
- Non Energy Uses	-	-	2.860	-	-	-	-	3.066

‡ Includes coking coal use and coal used as feed stock

@ T/D losses not accounted for.

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-	-	-	-	-	-	-	-	-	4.418	133.109
-	0.041	2.279	1.375	-	-	0.383	4.078	-	-	23.266
-	-	-	0.092	-	0.589	0.103	3.598	-	-	3.691
(-)0.159	0.085	0.056	(-)0.126	0.015	(-)0.272	(-)0.038	(-)0.563	-	-	3.453
(-)0.159	(-)0.044	2.223	1.409	(-)0.015	(-)0.317	0.318	1.043	-	-	149.241
2.848	1.905	5.333	16.65	1.043	6.078	2.648	44.066	36.351	42.980	(-)147.654
-	-	-	-	-	-	-	-	-	-	(-)0.095
2.948	1.805	5.333	16.866	1.303	8.339	2.649	46.173	-	-	(-)1.581
-	-	-	-	-	-	-	-	-	-	0.0
-	-	-	0.216	0.260	2.261	-	2.737	51.884	56.302	56.302
-	-	-	(-)0.144	(-)0.173	(-)1.507	-	(-)1.824	(-)34.684	(-)37.630	(-)37.630
-	-	-	(-)0.007	(-)0.009	(-)0.075	-	(-)0.091	(-)1.667	(-)1.701	(-)1.701
-	-	-	-	-	-	-	-	-	(-)3.649	(-)3.649
-	-	-	-	-	-	-	-	-	-	(-)2.998
3.007	1.761	7.556	18.059	1.028	5.761	2.966	45.109	-	13.322	101.587
3.007	1.761	7.556	18.059	1.028	5.761	2.966	45.109	15.533@	13.322	101.587
-	-	-	0.183	0.033	0.163	-	0.379	-	3.171	3.630
-	-	-	1.978	0.891	5.186	-	8.263	-	6.501	51.261
3.007	1.761	-	15.898	0.104	0.412	-	21.182	-	0.333	24.476
-	-	6.333	-	-	-	-	7.932	-	1.958	10.375
-	-	1.223	-	-	-	-	1.321	-	1.359	2.953
-	-	-	-	-	-	2.966	6.032	-	-	8.892

Table I.17: Commercial Energy Balance for India (1988/89)
Mtoe)

	PRIMARY ENERGY					SEC		
	COAL	CRUDE	NATURAL GAS	HYDRO POWER	NUCLEAR POWER	SOFT COKE	LPG	NAPHTHA
A. SUPPLY								
- Production	95.373	32.04	11.324	4.868	0.490	-	-	-
- Imports	1.455	17.811	-	-	-	-	-	-
- Exports	0.147	-	-	-	-	-	-	2.132
- Stock Changes	1.949	1.048	-	-	-	-	(-)0.23	0.067
B. AVAILABILITY	94.732	48.803	11.324	4.868	0.490	-	0.23	(-)2.199
C. CONVERSION	(-)52.284	-	(-)6.927	-	-	-	1.986	5.781
- Soft Coke	1.434	-	-	-	-	1.268	-	-
- Petroleum Refining	-	49.803	-	-	-	-	1.168	5.781
- LPG Extraction	-	-	0.818	-	-	-	0.818	-
- Power Generation	50.85	-	2.711	4.868	0.490	-	-	-
- Conversion Losses	(-)33.9	-	(-)1.924	(-)3.245	(-)0.327	-	-	-
- Aux Cons. in Power Station	(-)1.695	-	(-)0.015	(-)0.008	(-)0.016	-	-	-
- T/D Losses	-	-	-	-	-	-	-	-
- Nat Gas Flaring etc.	-	-	3.398	-	-	-	-	-
D. NET AVAILABILITY	42.448	-	4.397	-	-	1.268	2.216	3.582
E. CONSUMPTION	42.449	-	4.397	-	-	1.268	2.216	3.582
- Agriculture	-	-	0.086	-	-	-	-	-
- Industry	39.703	-	1.152	-	-	-	-	-
- Transport	2.745	-	-	-	-	-	-	-
- Residential	-	-	0.043	-	-	0.793	1.799	-
- Other Energy Uses	-	-	-	-	-	0.475	0.417	-
- Non Energy Uses	-	-	3.116	-	-	-	-	3.582

‡ Includes coking coal use and coal used as feed stock
@ T/D losses not accounted for.

ONDARY ENERGY

MOGAS	ATF	KEROSENE	HSD	LDO	FUEL OILS	OTHER PET PDTS	TOTAL PET PDTS	THERMAL POWER	TOTAL POWER	TOTAL ENERGY
-		-	-	-	-	-	-	-	5.358	144.095
-	0.038	2.870	2.533	-	0.458	0.538	6.437	-	-	25.703
-	-	-	0.103	-	0.009	0.193	2.437	-	-	2.584
(-)0.225	0.095	0.248	0.311	0.07	0.923	(-)0.648	0.611	-	-	3.508
0.225	(-)0.057	2.622	2.119	(-)0.07	(-)0.474	0.993	3.389	-	-	163.606
3.033	1.867	5.435	17.100	1.169	6.578	1.948	44.897	39.377	46.958	(-)52.621
-	-	-	-	-	-	-	-	-	-	(-)0.166
3.033	1.867	5.435	17.229	1.519	8.724	1.948	46.714	-	-	(-)12.089
-	-	-	-	-	-	-	0.818	-	-	0.0
-	-	-	0.139	0.350	2.146	-	2.635	56.196	61.554	61.554
-	-	-	(-)0.093	(-)0.233	(-)1.431	-	(-)1.757	(-)37.591	(-)41.153	(-)41.153
-	-	-	(-)0.004	(-)0.011	(-)0.071	-	(-)0.086	(-)1.796	(-)1.820	(-)1.820
-	-	-	-	-	-	-	-	-	(-)3.995	(-)3.995
-	-	-	-	-	-	-	-	-	-	(-)3.398
3.258	1.810	8.057	19.219	1.099	6.104	2.941	48.286	16.819@	14.586	110.985
3.258	1.810	8.057	19.219	1.099	6.104	2.941	49.286	-	14.586	110.985
-	-	-	0.091	0.033	0.180	-	0.304	-	3.471	3.861
-	-	-	1.794	0.97	5.477	-	8.241	-	7.118	56.214
3.258	1.810	-	17.334	0.096	0.447	-	22.945	-	0.365	26.055
-	-	6.753	-	-	-	-	8.552	-	2.144	11.532
-	-	1.304	-	-	-	-	1.721	-	1.488	3.684
-	-	-	-	-	-	2.941	6.523	-	-	9.639

Table II: Calorific Value of Different Fuels

Coal	1 MMT	0.49 mtoe
Natural Gas	1 million cu.m	856.8 toe
Electricity	12000 GWh	1 mtoe
Petroleum Products		
LPG	1 MMT	1.13 mtoe
Naphtha	1 MMT	1.075 mtoe
Mogas	1 MMT	1.07 mtoe
ATF	1 MMT	1.065 mtoe
Kerosene	1 MMT	1.045 mtoe
Diesel	1 MMT	1.035 mtoe
Fuel Oils	1 MMT	0.985 mtoe
Other Products	1 MMT	0.96 mtoe

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